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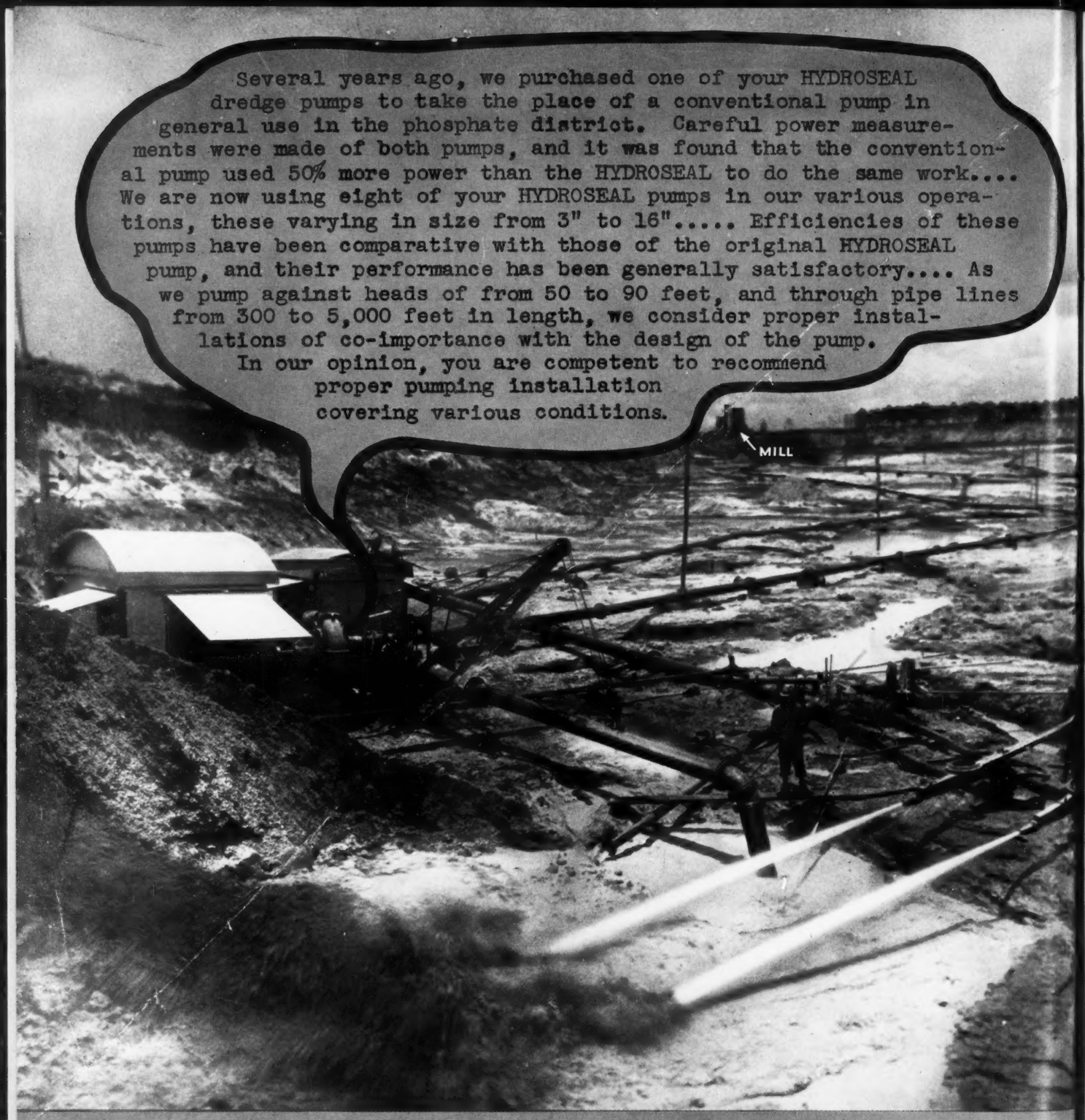
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H. C. PARMELEE
Editorial Director

Engineering and Mining Journal

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WILLARD CHEVALIER
Vice-President

A. W. FISHER
Manager

Cripple Creek, famous for a gorgeous past, now boasts a new mill, built in the latter part of 1935 but not hitherto described. Intended primarily to treat the ores of the Stratton Estate and of independent producers of the camp, it is nevertheless equipped to do a general custom business, using flotation, amalgamation, roasting, and cyanidation, as may be needed. Charles E. Tonry, superintendent of the plant, will tell about it in the November issue.

⁂

Tax Dilemma. An Ohio corporation, facing a $100,000 loss on its year's business, finds that it will have to pay a large tax bill. The concern has suffered a capital loss of $600,000, on which it may deduct only $2,000. Other operations resulted in profits of $500,000. Under the Ohio law dividends may not be paid when such payment would leave the company in a weak financial position. Since, therefore, the company cannot distribute the $500,000 it will have to pay the maximum tax on undistributed surplus. The directors of the company have been advised that they would be personally liable for any distribution of company funds with the corporation in its present condition. Tax experts believe this is typical of many concerns in much the same position.

⁂

A Collection of 35 diamonds, each stone of different color, is reported to have been acquired in South Africa recently by a Detroit business man. All were found in and around Kimberley and all are of the river-stone variety. Fifteen years' search were required in the assembling of the gems. They have left South Africa by airplane and were specially insured by Lloyds. The collection will probably be exhibited in the United States.

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Goverment Payroll. To an increasing degree since 1929 the Government has supplanted private industry as a source of the incomes realized by individuals in the United States, according to an analysis by the National Industrial Conference Board. Income derived from Government sources. which accounted for 8.5 per cent of the total in 1929, had increased in proportion to 17.5 per cent in 1934. Sums derived from Government in 1929 and 1934 showed an increase of 37 per cent while the amount from private industry and occupations sources dropped 43 per cent.

⁂

Pumps and Pumping figure in the lives of most mine superintendents, engineers, and foremen, and oftentimes importantly. Lamar Weaver, of Ducktown, Tenn., has been moved to write on the subject of mine drainage and its attendant problems. His article will begin in the November number.

⁂

Eight-hour Day. "We need the 8-hour day in industry, and good wages for the 8 hours. Some day the 6-hour day or even the 5-hour day will come. But not yet. Before we can reach the shorter work day we must learn to produce so that we can not only reduce prices but also raise wages." Henry Ford in an interview in the September issue of *Factory Management and Maintenance.*

⁂

The Big Ten. Leading gold mines of the world in 1935 ranked in the following order of production: Crown Mines, Government Areas, Randfontein, Homestake, New Modder, East Rand Proprietary, Sub Nigel, Lake Shore, New State, Springs. All except Homestake (United States) and Lake Shore (Canada) are in South Africa. Hollinger (Canada) was No. 11 on the list.

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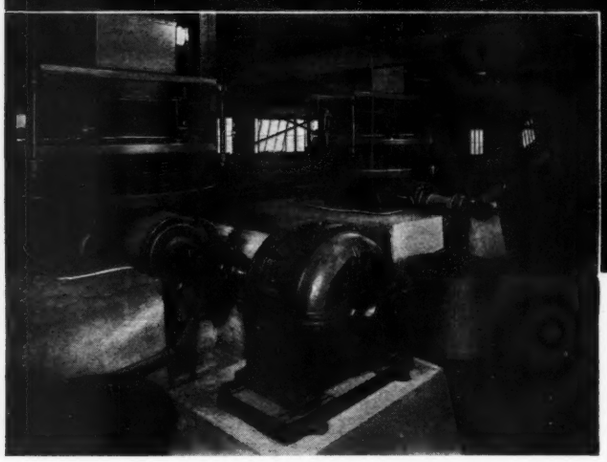
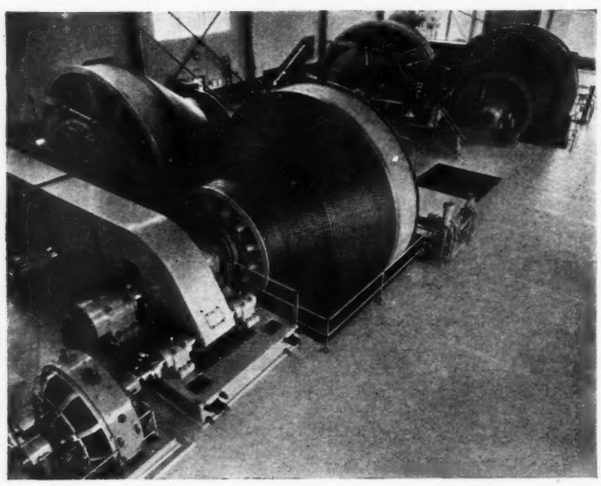


Two four foot Symons Cone Crushers crushing zinc ore. These crushers are built in types and sizes for mines large and small.



This hoist is typical of the many outstanding mine installations made by Nordberg.

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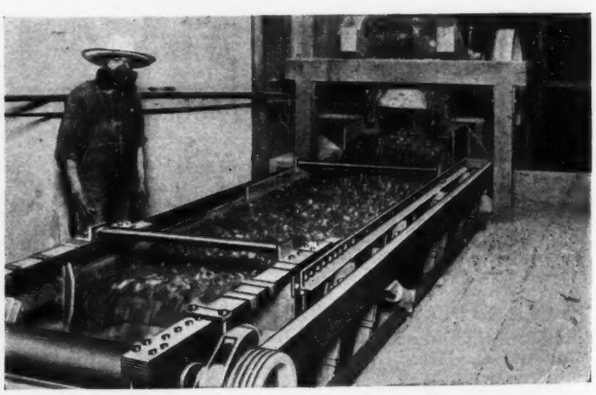

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Volume 137 OCTOBER 1936 Number 10

Manganese Research Makes Progress

THE LONG-TIME VIEW should be taken of research, especially where the desired goal is not immediately attained. Only when the objective sought is reached can the value of the intermediate steps leading up to it be properly appraised and credit fairly given—just as only when the man is grown is the value of the baby known, to hark back to a famous saying. Unfortunately, many people fail to take an intelligent attitude in this respect and look for quick returns on any money spent for investigative purposes. All this is well illustrated in connection with the efforts that are being made to find ways of utilizing the manganese contained in the large reserves of low-grade ores of the United States. This work is steadily making progress.

Domestic manganese, indeed, deserves more of the limelight which it received during those years preceding the depression when the steel interests of the country strove unsuccessfully to have Congress remove the tariff that had been protecting it since 1922. Important work is now on foot. Stimulated by the victory to be won if some means can be found to make this manganese commercially available, investigation has been under way at varying tempo for the past decade in Government and private laboratories. Processes of treatment have been developed for various ores, but the results have always fallen short of the end desired, although work of merit has been done and much new knowledge gained. Foremost in this investigation has been the United States Bureau of Mines, which has recently made new progress. The news that the Bureau engineers have produced pure manganese metal electrolytically by continuous deposition from sulphate solution has already been made public, as noted in these pages earlier this year. The technical details are presented on pages 510-513 of this issue. The work is still in the experimental stage, the results cited having been obtained in tests made on a laboratory scale with domestic ores from Nevada and the Olympic Peninsula, Washington. For the leaching operation that precedes the electrolysis, the experimenters have confined themselves to reagents of commercial purity, to keep the process within the limits of economic feasibility.

The next step is obviously the erection of a pilot plant, which it is earnestly hoped the Bureau will be able to provide. Here is something on which public money might well be spent, manganese being a commodity that is necessary in large tonnages to industry in both war and peace, as has been often said—but not too often. Such a plant, wherein the experimentation may be conducted on a larger scale, is indeed as necessary to the ultimate successful development of the process as the manganese itself is to the steel industry that uses it. To the possible contention that steel makers do not consume their manganese in the form of pure metal, the best answer is the suggestion that they do more research along this line themselves.

Opponents of the manganese tariff have roundly criticized the duty. Admittedly, through the fourteen years since it was levied it has proved ineffective in bringing out any large tonnage of ore from domestic sources, but one should note that this has been in the face of the hostility of the steel industry towards it and the constant threat that the duty would be removed, both of which have been deterrents to exploration and research; and the duty is even now cut in half so far as ores from Brazil are concerned by the provisions of the reciprocal trade agreement recently effected with that country. The argument of the critics has always been met with the answer that the tariff, if allowed to remain, would serve as a stimulus to search for new ore and to research for finding ways of beneficiating low-grade ores; that, though the price was high, the end sought was worth it. New ore reserves have indeed been found, as is well known, and now the researchers appear to be getting nearer to the solution of the metallurgical problem.

Midsummer Madness
In the Platinum Market

SOME SAY IT WAS THE HEAT. Others that it was Wall Street speculation. Perhaps it was a combination of both. Certain it is that the recent skyrocketing of platinum prices was not due to extraordinary demand in the usual channels of trade.

The year opened with platinum at $38 per troy ounce, a price which had been effective since October, 1935. By April the price had declined to $32, but in June it rose again to $38. July witnessed a rise to $40, and early August to $43. These fluctuations were not abnormal. The increases in June, July, and early August resulted mainly from revival of activity in the jewelry trade and were quite understandable. They were consistent with general business recovery. But when the price jumped to $53 on August 18, $62 on August 25, and $70 on September 2 it was quite evident that an unwelcome speculative element was playing with platinum.

At least one New York brokerage house is offering the public "a speculative opportunity in platinum." Explaining that gold can no longer be hoarded, it points out the possibility of using an alternative precious metal of limited supply as a hedge against inflation. The attractive features of platinum for this purpose are dressed up in appropriate style. Emphasis is placed on its price history and on the available surplus of production over consumption. The picture is intended to appeal to the speculative investor. But in typical fashion the brokerage house disclaims any guaranty of the accuracy or completeness of the information offered to the public, and says that the statements made and conclusions drawn therefrom must be considered as merely indicative.

In order to make speculation in platinum convenient and attractive, the brokerage house has acquired a quantity of the metal and cast it into three-ounce ingots of authenticated fineness. These are placed in a safe deposit vault and become the security for negotiable certificates of ownership issued to buyers. It is proposed to establish a trading market for these certificates, and possibly list them at a later date on one of the commodity exchanges. Thus the whole plan for speculative dealing is worked out in fine detail.

In the meantime the industrial market for platinum is upset in this country and abroad. The jewelry and chemical industries—largest consumers—are paying dearly for their metal. Platinum is essential to the chemical industry, and doubtless the price will have to be paid. But it is questionable whether the public will have an appetite for platinum jewelry at twice the accustomed price. Too many substitutes are available.

Platinum dealers deprecate the speculative movement, and producers also must regard it critically, pondering the wisdom of freely meeting the demand. As for the speculators, they must make their own decisions and take the risks in buying a commodity surrounded by many obscure factors. A British writer counsels caution, casting a reminiscent eye in the direction of the shellac and pepper fiascos in London that were precipitated by elements foreign to those trades. Platinum is experiencing a similar intrusion. Spectacular price increases are the order of the day, but equally precipitous drops may come without warning.

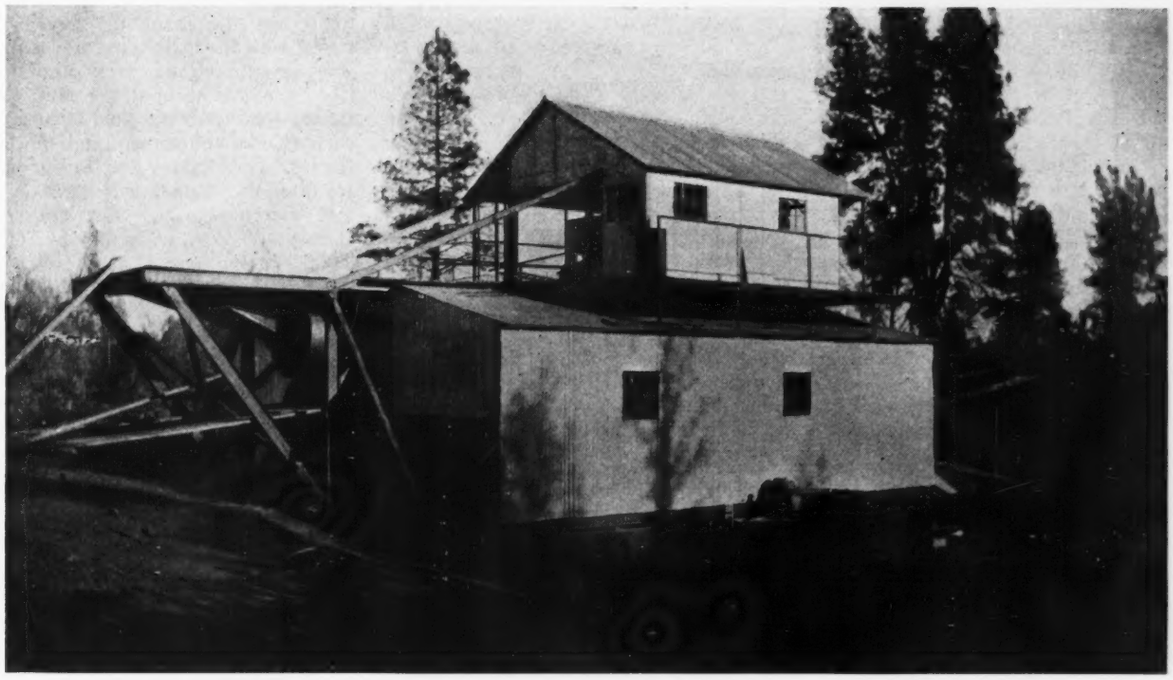
Speaking of the Distribution of Wealth

LAST DECEMBER, in opposing California's proposal to tax gold production, we pointed out the fundamental contribution of the mining industry to the general welfare of the community. Mines may be profitable or unprofitable, but as long as they are worked, "they give employment, disburse wages and salaries, purchase supplies, pay taxes, and sometimes dividends, and generally contribute to the prosperity of the State."

Supporting evidence of the wide distribution of wealth produced by the mining industry comes from the neighboring province of British Columbia, Canada. In 1934 the gross value of her mineral production was $42,305,297. Was this wealth hoarded? Or squandered? On the contrary it was distributed into the most constructive channels of industry and commerce. Wages and salaries took 35 per cent. Nearly 11 per cent was spent for equipment and machinery. Freight and express payments accounted for another 10 per cent. Next in order of magnitude was the purchase of foodstuffs, estimated at 9 per cent. Then follow, in minor percentages, disbursements for electric power, fuel, explosives, building supplies, lumber and timber, insurance, and other miscellaneous items. Dividends declared during the year amounted to 14 per cent of the value of the production.

In short, mining in British Columbia in 1934 not only paid its own way, but bought capital goods, consumer goods, and services that provided other employment in all the varied forms of activity that characterize modern industrial economy. What is true of British Columbia applies to mining countries the world around. The Transvaal offers a striking example. Working revenue of Transvaal mines in 1935 was £74,790,876. Working costs amounted to 56 per cent of revenue, and dividends 22 per cent. Stores consumed had a value of £24,829,266, including all manner of supplies, food, and equipment from bags and belting to wire and zinc dust.

Mining is a basic industry. It asks no favors, but it demands freedom from interference with the normal distribution of its wealth by unintelligent taxation.



SIX DAYS ONLY, with six men working, are required for dismantling and re-erecting this gold-washing plant of the Pioneer Dredging Company, which is operating a placer property near Redding, California. A 1¼-cu.yd. dragline bucket is used for digging

Novel Washing Plant

Designed for Shallow Placers

Sectionalized, its parts can be transported by auto truck . . . Time is saved in dismantling and erecting

John B. Huttl
Assistant Editor

ONE of the most significant developments in the last year or two in California and other Western mining states is the attention being given to shallow gold-bearing gravel deposits. Their profitable exploitation, however, is not always the easy problem it appears to be. These placers are usually small in area and the pay channel narrow and irregular; hence great care must be exercised in testing the ground and in the selection of the equipment if a good profit on the investment is to be assured. To meet these requirements, the equipment must be portable and of a size that will insure a maximum daily average yardage. Another factor that should be taken into consideration is the design and general arrangement of the plant. Much operating time is lost in dismantling and reassembling the plant after a given area has been worked out when the plant has been constructed in the conventional manner. To overcome this difficulty, employment of sectionalized equipment is essential.

The plant used at small placers consists of a digging element, usually a power shovel or a dragline, and a portable washing plant. In many instances the washery is mounted on skids or caterpillar tracks, but where the bedrock is fairly even and water can be obtained at reasonable rates it is practically always placed upon a shallow scow or barge. The hull is usually made of wood and the superstructures are of steel construction. Transportation to and erection at a new site are generally matters of considerable expense.

The Pioneer Dredging Company, operating a placer property near Redding, Calif., recognized this difficulty, and as a consequence installed the novel washing plant shown in the accompanying photographic reproductions. The outstanding feature is its sectionalized construction. All units are within the load-carrying capacity of a large truck, the heaviest piece—the main truss containing the screen drive mechanism and a built-in distributor—weighing about 7 tons. The method of transporting it on the truck is shown in one of the illustrations. The plant was designed by H. F. England, of Oroville, Calif., and its capacity is 150 yd. of gravel per hour. At the Redding operation the digging element employed is a No. 601 Lima dragline equipped with a 1¼-yd. Page bucket.

The washing plant is built entirely of

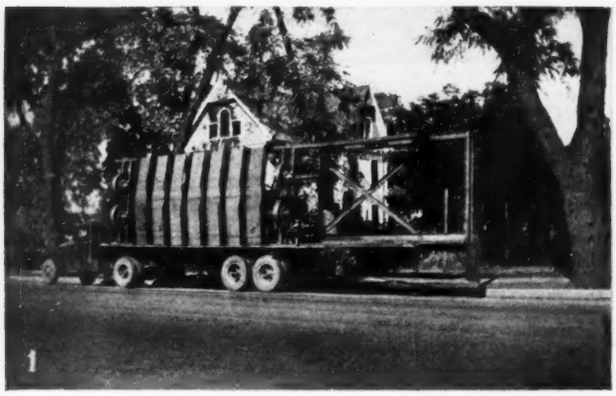
steel, including the hull, and is of the self-supporting type. The latter term is used locally to explain that the hull and the superstructure proper, with its gravel-treating machinery, are two separate units. In other words, the washing plant is held to the hull by a flange on the base of the superstructure instead of being integral with the hull, as is the conventional practice. Stresses or strains are thus avoided in the hull. Moreover, this feature permits removal of the washing plant from the hull and reerection upon skids or caterpillar tracks, should the character of the placer require such a change.

As to equipment used, the plant differs little from those operating in neighboring areas. It consists essentially of a 26x38-ft. hull composed of six steel pontoons, each 8 ft. 8 in. wide, 19 ft. long and 40 in. high, made from plates and angles; a revolving screen 48 in. in diameter and 25 ft. long, covered with screen sections containing $\frac{3}{8}$-in. perforations; a steel hopper with a grizzly spaced 6 in.; a 7-in. centrifugal pump capable of delivering 1,500 g.p.m. to the revolving screen; four small hand winches; a Koehler light plant; a stacker measuring 45 ft. between centers and employing a 24-in. belt conveyor; and a 50-hp. Caterpillar diesel engine, which actuates the revolving screen, pump, and other auxiliaries.

As mentioned previously, the distributor below the revolving screen is integral with the main truss and is divided into seven sections, each 30 in. wide. To these are secured the sectionalized sluices that form the gold-table area on each side of the screen, and the tailing sluices. Gold tables and tailing sluices are fitted with standard Hungarian riffles and mercury traps. The two tailing sluices are 4 ft. wide and 54 ft. long. Total sluicing area is about 740 sq.ft.

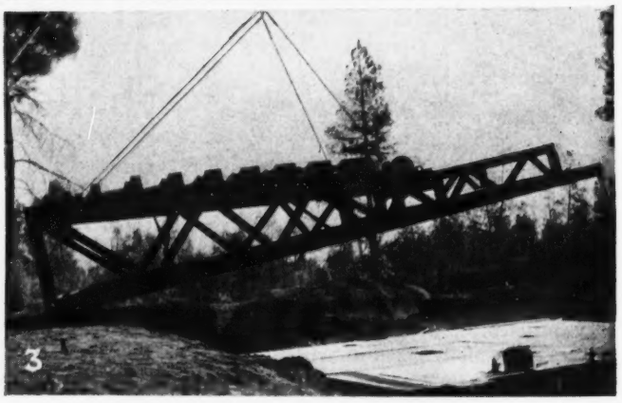
The housing, including the roof, is made entirely of 6-ft. steel frames covered with corrugated iron sheets, bolted together in the field. The plant is fireproof, and can be dismantled and reassembled in six days, with six men employed.

1 . . . . **MAIN TRUSS of the plant weighs about 7 tons, together with the driving gears and rollers for the trommel screen and fourteen sluice-box sections. Here it is being trucked to the site.**



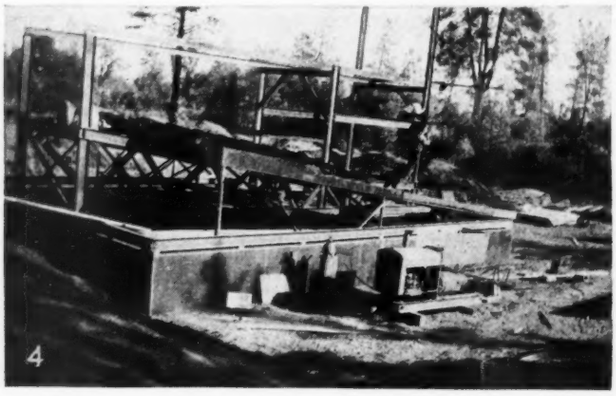
2 . . . . **STEEL PONTOONS are six in number, each 8 ft. x 8 in. wide, 19 ft. long and 40 in. high, and built from plates and angles. They make up the hull, which measures 26x28 ft.**

3 . . . . **LIFTING THE MAIN TRUSS SECTION into proper position for bolting it to the pontoons. The cables seen are attached to the bucket of the dragline shovel**



4 . . . . **THE FRAMEWORK BEGINS TO TAKE FORM as the sluice boxes are assembled and steel channel irons and beams are securely bolted into position. Portable electric welding equipment helps to speed the assembly**

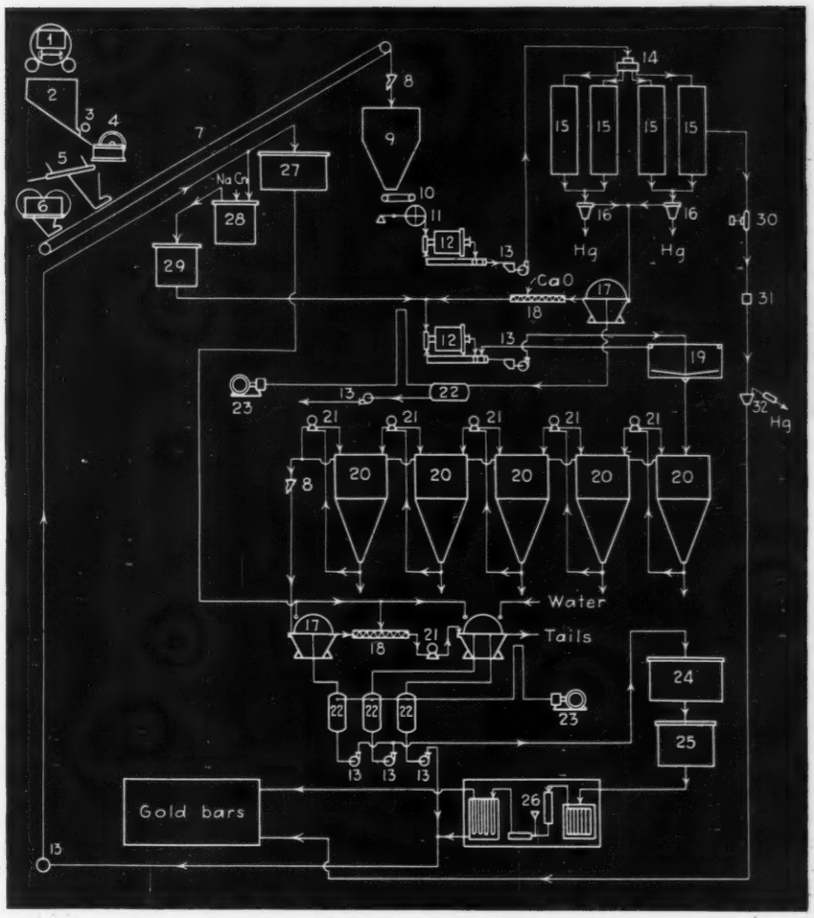
5 . . . . **THE TAILINGS STACKER measures 45 ft. between center of pulleys and will convey material on a 24-in. belt. A Caterpillar diesel engine located on the center of the upper deck supplies power for the revolving screen and pumps**



Gold in Paraná

Quartz veins discovered four years ago near the capital of this Brazilian State are now being worked . . . A 150-ton amalgamation-cyanidation plant was started in March

F. A. Fonseca Filho
General Manager
Mina Timbutuva Sociedade, Limitada
Paraná, Brazil



TIMBUTUVA MILL FLOWSHEET. The 150-ton plant is equipped for amalgamation and all-sliming cyanidation. It was placed in operation early this year

LEGEND

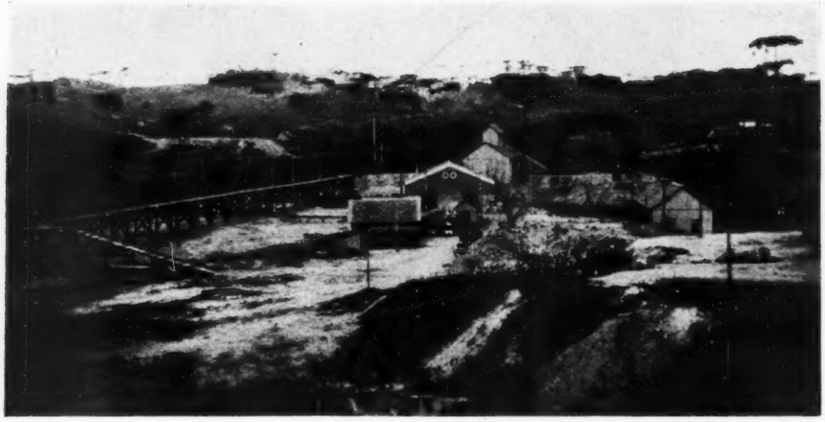
1. Dumper
2. Hopper
3. Chain feeder
4. Jaw crusher
5. Shaking screen
6. Crushing rolls
7. Belt conveyor
8. Head sampler
9. Ore bin
10. Apron feeder
11. Automatic weigher
12. Ball mill and classifier
13. Sand pump
14. Pulp distributor
15. Amalgamation tables
16. Amalgam traps
17. Drum filter
18. Endless-screw mixer
19. Thickener
20. Humboldt cyanidation tanks
21. Diaphragm pumps
22. Vacuum tanks
23. Vacuum pumps
24. Sand filter
25. Pregnant-solution tank
26. Merrill-Crowe precipitation plant
27. Sump tanks
28. Cyanide solution tank
29. Storage tank
30. Amalgam mixer
31. Amalgam press
32. Amalgam retort

KNOWN throughout Brazil for its good lumber and *mate*, the State of Paraná has recently been brought to the attention of the geologists of the country through the discovery of gold deposits within its borders. No veins of importance had ever been found before or ever looked for, although early in the seventeenth century the precious metal had been washed from river placers in several parts of the State. At that time the seekers after gold naturally turned to Minas Geraes, practically the only producer of that metal.

About four years ago, the first gold-quartz vein was found in Timbutuva, a small place 14 miles from Curityba, Paraná's capital, by a prospector in quest of mica. Granitic gneiss and metamorphic schists of Archean age constitute the country rocks for miles around. Exploration work on a small scale was started on two or three outcrops and an attempt made to sink on one of them. Lack of capital and of experience caused the failure of this first venture. Two years later, the Mina Tumbutuva Sociedade, Limitada, a newly organized company, bought the property and started exploration, sinking two shafts, one vertical and one inclined, and driving tunnels and drilling from the surface to prove the four main quartz veins found.

The mine is situated 2,700 ft. above sea level and one mile from the highway to Curityba, this location facilitating the transportation of materials and machinery. The State Capital can be reached in half an hour by either truck or motor car. Near-by woods supply timber for construction and mining purposes, pine being the wood most used and very abundant in Paraná. A small river crosses the property and supplies water for milling operations. The region is very flat, and no waterfalls are to be found for many miles around. The recently built power line supplies electric power from Curityba at 13,000 volts to an 800-kva. substation near the mill. Water for milling is supplied by two 3-in. centrifugal pumps, one of these being kept in reserve.

The strikes of three of the veins are known, respectively, to be: N. 78 deg. E., N. 20 deg. E., and S. 80 deg. E. The first and second of these veins dip southeast and the fourth dips north, the angle in all of them varying from 25 to 70 deg. All of the veins have been traced for more than two miles, but only one of them has been explored sufficiently deep to allow judgment as to the kind of deposit it is or to make possible deter-



MINE SHAFT and compressor plant of the Timbutuva company, which is working recently discovered gold-quartz veins near Curityba, capital of the State of Paraná, Brazil

mination of its origin. The ore that is of commercial grade is the result of secondary enrichment of primary quartz veins containing a more or less strong mineralization of pyrites. At a depth of about 165 ft. the quartz runs out in a pegmatite dike that carries some pyrites but never assays more than 0.5 gram of gold per ton.

Down to the first level, at 90 ft. from the surface, the secondary enrichment is marked. Not only is pyrite abundant but also zinc blende, galena, chalcopyrite, and covellite. The gold content varies from very low to very high. Consequently, all headings and stopes must be sampled daily.

So far as these veins are known, they are not continuous but are a series of shoots more or less irregular in shape and size, sometimes connected by very thin veins, sometimes quite interrupted and far apart. All quartz veins of the district are associated with pegmatites more or less mineralized. As a rule, these pegmatites contain much quartz, microline, and plagioclase in large crystals and very little epidote, muscovite, and chlorite. No doubt the quartz was segregated from the intrusive pegmatite. The feldspars were quickly cooled and crystallized and the quartz continued upward, carrying its metallic minerals, giving origin to the irregular primary veins.

Surface waters were responsible for the secondary enrichment. The best part of these veins seem to have been eroded, judging from the high values found in the outcrops and from the rather shallow depth at which the veins pass into pegmatites. A series of fissures striking more or less N. 10 deg. E. apparently played a part in the process of enrichment. One can usually expect good ore where these fissures are many and close together. Seldom does a quartz vein follow one of the N. 10 deg. E. fissures. These are post-mineral fissures, and when they are filled only products of reconcentration are present, sulphides being the most common.

The thickest lens (27 ft. thick on the average) has been reached at 165 ft. and a raise driven through it upward to the first level. This was done in order to study the variation of grade with the depth. Up to the 90-ft. level the increase in grade is more or less gradual. Above that level the oxidized zone is reached and there the gneiss is decomposed and surface agents have altered the veins to some extent. Consequently, in that zone the enrichment is much more marked but very irregularly distributed, so that no uniformity of grade can be observed.

The vertical shaft is located between two parallel veins about 500 ft. apart. Up to the present little ore has been mined, all attention having been given to exploration and development. On the first level, owing to the decomposed condition of the rocks, the drifts and raises have to be timbered. On the second level, however, no timber is necessary. The gneiss is so hard that even in very wide tunnels the roof stands by itself. More than 5,800 ft. of drifts have been driven on both levels for exploration purposes and for blocking out reserves. Owing to much fissuring and some faulting, a careful system of crosscutting and diamond drilling has to be followed continuously.

All mine water, about 300 g.p.m., is handled by a 3-in. Cameron electric pump. Two 500-c.f.m. Ingersoll-Rand electrically driven compressors supply compressed air to the hammer drills used. The drill-sharpening shop is equipped with Ingersoll-Rand machines.

Amalgamation and cyanidation are used in the mill. This very modern 150-ton plant is without doubt the best equipped in the country. It was designed and furnished by Humboldt-Deutz Motoren A. G., Cologne, Germany, following a long series of tests on adequate samples. Details are given in the accompanying flowsheet.

Ore is delivered to the mill in mine cars which are hauled to the car dumper by a light hoist. A 650x450-mm. jaw crusher breaks the ore to 4-in. size. This is followed by a set of 1,150x400-mm. crushing rolls. The discharge, reduced to ⅜-in. size, is conveyed by belt to a 100-ton bin. From this the ore is removed by an apron feeder, is automatically weighed, and delivered to a 1,600x2,000-mm. ball mill. In this it is ground to 40 mesh in closed circuit with a classifier. The overflow is pumped to the distributor and pulp sampler and thence to four vibrating amalgamating tables. One 16-sq.m. drum filter dewaters the pulp coming from the tables and an endless screw mixer sends it, together with the necessary addition of lime, to another 1,600x2,000-mm. ball mill. Here everything is reduced to slimes, this operation being done in closed circuit with cyanide solution. All slimes are pumped to a Dorr-type thickener and thence to five leaching tanks equipped with Humboldt vibrators, where the gold extraction is accomplished by cyanidation.

Two drum filters are used for filtering and washing the slimes. All rich solution is pumped to sand filters and to a series of vacuum clarifying leaves. Precipitation is done with modern Merrill-Crowe equipment. Precipitate and amalgam are sent to the smelting department

MILL AND CRUSHING PLANT, also the laboratory and the office, of the Timbutuva company. The amalgamation-cyanidation plant was designed and supplied by Humboldt-Deutz Motoren, Cologne, Germany

Autogenous Smelting

Of Copper Concentrates

With

Oxygen-enriched

Air

Interesting possibilities are suggested by the calculations here presented

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"AUTOGENOUS SMELTING" as here used refers to a combined roasting and smelting operation upon copper or copper-nickel concentrates. The dried concentrate, mixed with oxygen or oxygen-enriched air, is burned in suspension to produce a material which is so hot that when it settles on the hearth of the combustion chamber it smelts autogenously to molten matte and slag.

The possibility of using such a process on a commercial scale depends on the cost of oxygen. If oxygen of from 90 to 98% purity can be produced at a cost of less than $4 per ton, the process appears to have attractive possibilities, inasmuch as calculations indicate that, per ton of concentrate smelted, the cost of oxygen for autogenous smelting is generally lower than the cost of coal for normal reverberatory smelting.

Apparently, oxygen can be produced on a large scale at the point of consumption for less than $4 per ton. Nagel[1] states: "Low-cost air-liquefaction plants producing oxygen of 95% purity situated on the site of consumption can provide gaseous oxygen at an operating cost of $3.50 per ton with power at ½c. per kw.-hr. and at $5 per ton with power at ¾c. per kw.-hr., when producing 150 tons daily from three 50-ton units." Since most copper smelters can obtain power for less than ½c. per kw.-hr., it should be safe to assume an oxygen cost of $3.50 per ton in cost calculations. This figure will be used in all cost calculations made in this paper.

Development of Suspension Roasting—The possibility of successful application of autogenous smelting depends on the success which has been achieved in the development of suspension or shower roasting of flotation concentrates. In recent years several successful installations using the suspension roast principle have been made. The development of the Freeman pyrite burner in 1929 is of particular interest here.[2] In this burner dried pyrite concentrate mixed with air is introduced at the top of a vertical refractory-lined shaft. After the shaft has been brought up to operating temperature, the combustion of the pyrite is maintained without the use of an oil flame or electric arc for ignition. Very little excess air is required, and the flame temperature is reported to have reached 1,150° C. The cinder of magnetic iron oxide settles out of the flue gases readily. It contains below 2% sulphur.

The following quotations from Freeman's article are of particular interest:

1. "Experiments at Shawinigan soon demonstrated that all flotation sulphides can be rapidly roasted in suspension in air but that they do not act alike. Thus, copper concentrate has a low heating value, and special means must be adopted to maintain continuous combustion. We have demonstrated that it is possible to completely roast or to produce mattes or even metallic copper with no other than the heat consumed in the ore itself.

2. "Sulphide particles are fused, become puffed, and form minute hollow balls of iron oxide in a state of incipient fusion and exhibit a tendency to agglomerate; consequently, the oxide product is not an objectionable dust."

About the same time that Freeman was developing his burner, the metallurgists of the Consolidated Mining & Smelting Company, at Trail, were experimenting with methods whereby they could burn their zinc concentrate in suspension and produce a calcine suitable for leaching in dilute sulphuric acid. Difficulties which they encountered were due largely to the very dusty nature of the calcine and to the high temperature developed in the combustion chamber when working on dried concentrate. Successful methods were evolved for handling these difficulties, and a roaster of high capacity and high economy was developed, so that all roasting of zinc concentrates is now done at Trail by burning in suspension.

At Trail most of the moisture must be dried out of the concentrate, which must then be passed through a ball mill to disintegrate the lumps. A similar method of treatment was adopted by Freeman, who worked with a burner feed carrying about 2% moisture. A feed carrying not more than 2 or 3% moisture appears to be a prerequisite of all suspension roasting operations.

The next recorded development in suspension roasting was at Anaconda, where a high-grade copper concentrate mixed with the necessary siliceous flux for smelting was roasted in suspension in an experimental shaft.[3] The shaft, which was 3x3 ft. in cross-section and had an effective height of about 20 ft., was set above a small reverberatory furnace, into which both the exit gases and calcine were discharged. The concentrate was desulphurized from 31.5% sulphur down to a minimum value of about 15% sulphur. In one test the gas leaving the shaft is reported to have contained 11.7% SO_2 and 3.7% O_2. A maximum temperature of about 1,500° F. is reported. This experiment indicated that a shaft roaster of commercial size should be quite successful and that considerable advantage should be derived from charging the hot calcines direct to a reverberatory furnace. The capacity of the experimental shaft was

stated to be from 4.5 to 5 tons of feed per day per square foot of cross-section. Regarding flue dust, the following is quoted from Laist and Cooper's article:[4]

"It was expected that the dust losses from the reverberatory would increase when operated in conjunction with the shaft, but it was thought that losses of this kind would not be excessive and would probably be much less in a large furnace than in a small one. As a matter of fact, the copper in the dust leaving the reverberatory furnace averaged less than 2.5% of the total input. Considering the short distance between the flue and the point where the hot calcine entered the furnace, and also considering that the calcine dropped through the flame, this result was satisfactory."

These three examples of suspension roasting which have been cited indicate that its feasibility appears to be definitely established. It should not, therefore, be taking too far a jump into the unknown to consider roasting copper concentrates in suspension in an oxygen-enriched air mixture, the object of the enriched air being to allow sufficiently high temperatures to be established in the combustion chamber so that molten matte and slag will be formed from the hot calcine as it settles upon the hearth of the chamber.

A Thermochemical Study of Autogenous Smelting—With the large amount of fairly reliable data which is available at present, a thermochemical study of autogenous smelting should be of considerable help in predicting whether the process may be practically applied or not. It should at the same time indicate with a fair degree of accuracy what conditions must be maintained before any success by actual experiment can be achieved. Therefore, with these objects in view, the remainder of this article will be devoted to such a study.

Probably one of the weakest points in most thermal calculations is in regard to the reliability of the data used. Before any calculations were made, therefore, a good deal of attention was paid to the collection of the necessary data. An attempt has been made to gather the most reliable available.

1. *Heats of Formation*—Heats of formation of the substances entering into the calculations probably contain less source of error than any of the other data used. The values given in the "International Critical Tables," Vol. 5, 1929, are slightly more accurate than those in Richards' "Metallurgical Calculations," and therefore they have been used here. No data are available regarding the heat of formation of chalcopyrite or pyrrhotite, so the sulphides in the copper concentrates have been considered for purposes of calculation to be as free Cu_2S, FeS, and FeS_2. For the reason that the heat of formation of all sulphides is quite small compared to the heat of formation of the oxides which are formed from them on roasting, any error introduced due to the use of the wrong heat of formation for compound sulphides will have little effect on the final value of the heat evolved in the roasting operation.

Table I—Mean Specific Heats of Solid Compounds Between 0° C. and t° C.[4].

In Calories per Kilogram per °C

Substance	Temperature (t°C.) 800°	900°	1,000°	1,100°	1,200°	1,300°	1,400°	1,500°	Melting Point of Substance, °C.
FeS	0.175	0.176	0.176	0.176	a0.222	a,b0.218	a,b0.215	a,b0.213	1,195
FeO	0.186	0.188	b0.189	b0.190	b0.192	b0.193	a,b0.247	a,b0.245	1,380
Fe_3O_4	0.218	0.223	b0.228	b0.233	b0.238	b0.243	b0.248	b0.252	1,580
Fe_2O_3	0.212	0.215	b0.219	b0.224	b0.230	b0.237	b0.246	b0.252	1,580
Cu_2S	0.141	0.140	b0.138	b0.137	a,b0.161	a,b0.158	a,b0.156	a,b0.154	1,130
SiO_2	0.257	0.260	0.263	0.265	0.267	0.268	0.269	0.270	1,600–1,750
Al_2O_3	0.256	0.263	0.269	0.275	0.280	0.285	0.290	0.296	2,050
CaO	0.228	0.231	b0.234	b0.238	b0.242	b0.248	b0.255	b0.263	2,570
MgO	0.271	0.275	0.278	0.281	0.283	0.286	0.288	0.290	2,800

[a]Specific heat includes heat of fusion.
[b]Specific heat is extrapolated value of the specific heat equation.

Table II—Mean Specific Heats of Gases Between 0° C. and t° C.[5]

In Calories per Cubic Meter per °C

Temp. t°C.	N_2, O_2, and CO	SO_2 and CO_2
0	0.310	0.411
100	0.311	0.419
200	0.313	0.428
300	0.314	0.438
400	0.316	0.448
500	0.317	0.458
600	0.319	0.467
700	0.321	0.476
800	0.323	0.484
900	0.326	0.491
1,000	0.328	0.498
1,100	0.330	0.504
1,200	0.332	0.511
1,300	0.334	0.518
1,400	0.337	0.524
1,500	0.339	0.529

Estimated limits of error in above values is given as 3%[5].

2. *Specific Heats*—Specific heats of all substances considered have been taken from the data recently issued by the United States Bureau of Mines.[4,5] Inasmuch as the equations given in the Bureau of Mines papers are rather inconvenient for repeated use, they have been used only in the preparation of a table giving mean specific heats when the substance is heated between 0° C. and t° C., the values being calculated at every 100° C. interval. These values are shown in Tables I and II.

3. *Heat Contents of Solid Compounds*—In the preparation of Table I it was necessary to know the total heat required to heat the substance from 0° C. to t° C. For the lower temperatures a table of these values is supplied by the United States Bureau of Mines. For most of the higher temperatures it was necessary to calculate these values by integration of the specific heat equation of each substance. Many of the higher values represent an integration ot the specific heat equation as extrapolated beyond the temperatures of experimental measurement, and so they cannot be expected to be as accurate as the lower temperature values, which are generally given as having a limit of error of from 2 to 5%. Except for Cu_2S and FeO (whose heats of fusion had to be estimated), the extrapolated values given are probably not in error by more than 5 to 7%.

4. *Heat Content of Molten Furnace Matte and Slag*—It is important to know as accurately as possible the total heat required to raise average reverberatory furnace matte and slag from 0° C. to the molten state. It is from these values that the estimate of final matte and slag temperatures will be obtained.

(*a*) *Heat Content of Matte:*

In the heat balances made at Anaconda[6] the value of 208 calories per kg. was used. Landis [7] gives the heat value of a liquid 47% matte as 204 calories per kg. at 1,000° C. This is a calorimetric value. Landis also states that the heat of fusion of this 47% matte is 30 calories per kg. (melting point 1,000° C.). If it is assumed that this matte has a specific heat of 0.17, the heat content at 1,200° C. is 204 + 34 = 238 cal. per kg.

The following is a calculation of the heat content of a pure 25% matte using Landis' value of 30 calories per kg. for heat of fusion and the Bureau of Mines values of specific heats. Assume the melting point of matte as 1,000° C. and also assume it contains only Cu_2S and FeS.

0.313 Cu_2S@0.138×1,000
= 43 cal.
0.687 FeS@0.176×1,000
= 121 cal.
Heat of fusion
= 30 cal.

Total heat in liquid matte at 1,000°C.
= 194 cal.
Heat required to raise 200°C@0.17
= 34 cal.

Hence, total heat in matte at 1,200°C.
= 228 cal. per kg.

A value of 230 cal./kg. for molten matte at 1,200° C. should be a fair estimate for average matte (20 to 40% Cu.). This value was used in all the thermal calculations made.

(*b*) *Heat Content of Slag*—Anaconda [6] gives a value of 322 cal./kg. to its reverberatory furnace slag. Butts[8] states that the heat content of liquid silicate slags at their melting point varies from about 300 to 450 cal./kg., depending on their melting point. He states, also, that the specific heat of liquid silicate slags varies from 0.25 for basic slags to 0.30 for acid slags.

The following is a calculation of the heat of a typical clean furnace slag at 1,200° C.:

Heat per 100 kg. of slag: (Heat per mo. taken from Bureau of Mines tables)

$37\ SiO_2 = \frac{37}{60} \times 19{,}200 = 11{,}800$ cal.

$46\ FeO = \frac{46}{72} \times 16{,}400 = 10{,}500$ cal.

$8\ Al_2O_3 = \frac{8}{102} \times 34{,}350 = 2{,}700$ cal.

$3\ CaO = \frac{3}{56} \times 16{,}200 = 870$ cal.

$2\ MgO = \frac{2}{40} \times 13{,}700 = 685$ cal.

$4\ Fe_3O_4 = \frac{4}{232} \times 66{,}000 = 1{,}140$ cal.

Total = 27,695 cal.
Add 20% for heat of fusion = 5,540 cal.

Total heat in slag at 1,200 deg. C.
= 33,235 cal. per 100 kg.
= 332 cal. per kg.

The addition of 20% for heat of fusion in the foregoing calculation is probably quite liberal, as these slags do not appear to have a definite melting point, so it is difficult to see how they can contain an appreciable latent heat of fusion.

This indicates that a value of 330 cal./kg. for molten slag at 1,200° C. should be a fair estimate and is probably inclined to be a little on the large side and should, therefore, provide a small factor of safety to the thermal calculations in which it has been used.

5. *Heat Losses by Radiation and Conduction From Smelting Chamber*—To complete the data necessary to make a complete thermal calculation of the autogenous smelting process, one must decide the amount of heat lost by radiation and conduction from the furnace in which the operation is conducted.

It will be assumed in the first balances made that the operation is conducted by blowing the dried concentrate with the oxygen-enriched air into an average-size reverberatory smelting furnace, using burners similar to those used for firing pulverized coal. All heat will in this operation be supplied by the burning of the concentrate, and no carbonaceous fuel will be burned except possibly to warm up the furnace after a shutdown. Furnace temperature will be approximately the same as in normal smelting. It may be assumed, therefore, that heat losses by conduction and radiation will be approximately the same.

From a heat balance made on an Anaconda[6] furnace for a six-month period ended June 30, 1920, a value of 476 million B.t.u. per furnace day was obtained as the radiation and unaccounted for loss from furnace and boiler setting. A similar balance for January, 1905, gives a value of 441 million B.t.u. per furnace day in the Anaconda operation, as radiation, conduction, and unaccounted for loss from its furnace and boiler setting.

Another method of determining heat loss is by estimating the percentage of total heat input which is lost by radiation and conduction. From a number of published articles on waste-heat boiler practice,[7] it appears that an average figure for the total heat consumed by smelting plus radiation and conduction from the furnace, flue, and boiler setting is 40 to 45% of the heat in the coal as fired. About 20 to 25% of this heat is consumed in actual smelting of the charge. This leaves about 20% of the heat to be consumed by radiation and conduction from the furnace and boiler setting. With 100 tons of coal burned per day, there is a gross input of about 2,600 million B.t.u. Therefore, heat lost by radiation and conduction from the furnace, uptake flue, and boiler setting amounts to 2,600 × 0.20 = 520 million B.t.u. per furnace day.

Another way to obtain an approximation of radiation and conduction loss from a reverberatory furnace is to calculate directly the heat loss from a silica brick furnace roof and assume that this is one-third of the total heat lost by the whole furnace (not including flue and boiler setting).

Assume: Average temperature of the furnace = 2,500°F. Silica brick roof, 15 in. thick (average), outside area = 30×110=3,300 sq.ft.
Conductivity of silica brick = 6.0 + 0.0033t°F.—B.t.u./sq.ft./hr./in. thick/°F.
Using the above data, the outside temperature of the roof surface works out to 475°F., at which temperature the heat emitted = 1,475 B.t.u. per sq.ft. per hour.
Hence heat lost by the roof per day = 1,475×3,300×24 = 117 million B.t.u./day.
Total heat lost by furnace = 117×3=351 million B.t.u./day.

The foregoing figures obtained by the three independent methods indicate that for the reverberatory furnace alone a minimum value of 300 million B.t.u. and a maximum value of 500 million B.t.u. per furnace day may be taken as the heat loss by conduction and radiation. A value of 450 million B.t.u. per furnace day has been used in the thermal balances presented in this paper.

If we assume that 1,500 tons of solid charge per day is smelted in the reverberatory chamber, then the loss of heat at 450 million B.t.u./furnace day becomes 8,330 calories per 100 kg. of solid charge. This value of 1,500 tons per day is quite conservative. I will show later that, due to the relatively small volume of gas formed in autogenous smelting, the furnace chamber should easily have a capacity of 3,000 tons per day. I have assumed that at the 3,000-ton rate the radiation and conduction loss is reduced to 4,200 cal./100 kg. of solid charge.

Preliminary Thermal Calculations—To gain some idea of the degree of confidence which can be placed in thermal calculations on autogenous smelting, two preliminary calculations will be made on actual installations of suspension roasters using ordinary air, the object being to see how the calculated temperatures check with the temperatures actually obtained.

The Freeman Pyrite Burner

Given:
Pyrite concentrate analysis = 46.0% Fe, 50.2 S, 3.8% SiO_2+CaO, etc.
Calcine analysis = 2% S approximately.
Dry-gas analysis = 12% SO_2+88% N_2+O_2.
Moisture in concentrate = 2% of dry weight of concentrate.
Assume:
All oxidized Fe is as Fe_3O_4.
All oxdized S is as SO_2.
Take 100 kg. of concentrate (dry weight).
Then in calcine produced: (Assume it contains 1.5 kg. of S as FeS).

Fe as FeS $= \frac{1.5}{32} \times 56$
= 2.6 kg. Fe as FeS
Fe as Fe_3O_4 = 46—2.6
= 43.4 kg. Fe as Fe_3O_4
Oxygen as $Fe_3O_4 = \frac{43.4}{168} \times 64$
= 16.5 kg. O as Fe_3O_4
SiO_2+CaO, etc. = 3.8 kg.
S = 1.5 kg. as FeS

Total weight of calcine 67.8 kg.
Sulphur burned = 50.2 — 1.5
= 48.7 kg. S as SO_2 = 97.4 kg. of SO_2

Volume of SO_2 at N.T.P. $= \frac{97.4}{64} \times 22.4$
= 34.1 cu.m. of SO_2

Total volume of dry gas $= \frac{34.1}{0.12}$
= 284 cu.m. of dry gas at N.T.P.
O_2+N_2 in dry gas = 284—34.1
= 249.9 cu.m. of O_2+N_2

Volume of H_2O in "wet" gas $= \frac{2}{18} \times 22.4$
= 2.5 cu.m.

Heat of reaction:
Heat of formation of products of combustion:

43.4 kg. Fe as Fe_3O_4@1,588	=	69,000 cal.
2.6 kg. Fe as FeS@413	=	1,075 cal.
48.7 kg. S as SO_2@2,160	=	105,000 cal.
Total		175,075 cal.

Heat of formation of active compounds before combustion:
46.0 Fe as FeS_2@638 = 29,300 cal.

Hence, heat of reaction 145,775 cal.
Heat required to vaporize 2 kg. of H_2O = 1,200 cal.

Heat available to raise temperature of products = 144,575 cal.
Heat capacity of products: (Final temperature of 1,200°C. assumed)

67.8 kg. calcine@0.24	= 16.3 cal./°C.
34.1 cu.m. of SO_2@0.51	= 17.4 cal./°C.
2.5 cu.m. of H_2O@0.52	= 1.3 cal./°C.
249.9 cu.m. of N_2+O_2@0.332	= 83.0 cal./°C.
Total	= 118.0 cal./°C.

Theoretical maximum temperature rise $= \frac{144{,}600}{118.0} = 1{,}225$°C.

If the feed and air go in the burner at 25° C., the theoretical temperature attained in the burner is 1,250 ° C.

Freeman reports an actual temperature of 1,150° C. When due allowance has been made for radiation loss from the chamber, the theoretical temperature attained will probably be very close to the actual value of 1,150° C.

(b) **The Anaconda Shaft Roaster**

Given:
Feed, analysis 27% Cu, 7.1 SiO_2, 30.8 Fe, 31.5 S
Calcine analysis 19.5% S
Dry gas analysis
= 11.7% SO_2, 3.7% O_2, 84.6% N_2
Moisture in feed
= 0.4% of dry weight of feed.

Assume:
All oxidized Fe is as Fe_3O_4
Weight of calcine = 96% of weight of feed

Take 100 kg. of feed.

In feed:

$$\text{S with Cu as } Cu_2S = \frac{27}{127}\times 32$$
$$= 6.8 \text{ kg. of S as } Cu_2S$$
$$\text{S with Fe as FeS} = \frac{30.8}{56}\times 32$$
$$= 17.6 \text{ kg. of S as FeS}$$
$$\text{S as "free atom"} = 31.5-24.4$$
$$= 7.1 \text{ kg. of S as "free atom"}$$
$$\text{Hence Fe as } FeS_2 = \frac{7.1}{32}\times 56$$
$$= 12.4 \text{ kg. of Fe as } FeS_2$$
$$\text{Fe as FeS} = 30.8-12.4$$
$$= 18.4 \text{ kg. of Fe as FeS}$$

In calcine:
S with Cu as Cu_2S = as before
= 6.8 kg. of S as Cu_2S
S with Fe as FeS = (19.5)(.96)—6.8
= 11.9 kg. of S as FeS

$$\text{Fe as FeS} = \frac{11.9}{32}\times 56$$
$$= 20.8 \text{ kg. of Fe as FeS}$$
$$\text{Fe as } Fe_3O_4 = 30.8-20.8$$
$$= 10.0 \text{ kg. of Fe as } Fe_3O_4$$
$$\text{S as } SO_2 = 31.5 - 18.7$$
$$= 12.8 \text{ kg. of S as } SO_2$$
$$\text{Volume of } SO_2 \text{ formed} = \frac{12.8}{32}\times 22.4$$
$$= 8.96 \text{ cu.m. of } SO_2 \text{ at N.T.P.}$$
$$\text{Total volume of dry gas} = \frac{8.96}{0.117}$$
$$= 76.6 \text{ cu.m. of dry gas at N.T.P.}$$
$$O_2+N_2 \text{ in dry gas} = 76.6 - 9.0$$
$$= 67.6 \text{ cu.m. of } O_2+N_2$$
$$\text{Volume of } H_2O \text{ in exit gas} = \frac{0.4}{18}\times 22.4$$
$$= 0.5 \text{ cu.m. of } H_2O$$

Heat of reaction:
Heat of formation of products of combustion:
10.0 kg. of Fe as Fe_3O_4 @ 1,588
= 15,880 cal.
20.8 kg. of Fe as FeS @ 413
= 8,600 cal.
12.8 kg. of S as SO_2 @ 2,160
= 27,650 cal.

Total 52,130 cal.

Heat of formation of active compounds before reaction:
12.4 kg. of Fe as FeS_2 @ 638
= 7,920 cal.
18.4 kg. of Fe as FeS @ 413
= 7,610 cal.

Total = 15,530 cal.
Heat of reaction
= 36,600 cal.
Heat required to vaporize $H_2O = 0.4\times 600$
= 240 cal.

Heat available to raise temperature
= 36,360 cal.

Average heat capacity of products, assuming final temp.
= 800°C.
32.7 kg. FeS @ 0.175
= 5.73 cal./°C.
33.8 kg. Cu_2S @ 0.141
= 4.72 cal./°C.
29.5 kg. of oxides @ 0.24
= 7.08 cal./°C.
8.96 cu.m of SO_2 @ 0.484
= 4.33 cal./°C.
67.6 cu.m of $N_2 + O_2$ @ 0.323
= 21.80 cal./°C.
0.5 cu.m of H_2O @ 0.46
= 0.23 cal./°C.

Total = 43.89 cal./°C.

Theoretical maximum temperature rise
$$= \frac{36{,}360}{43.89} = 827 \text{ deg. C.}$$

If feed and air go into roaster at 23° C., final temperature = 850 ° C. The actual maximum temperature obtained when roasting to around 20% sulphur in the calcine was 800° C., approximately. When allowance is made in the foregoing calculation for heat lost by radiation and conduction, the theoretical temperature would probably be somewhat lower than the actual temperature obtained. The check between actual and theoretical values is, however, much closer than might be expected when it is considered that proper sampling of the calcine and gases must have been difficult. Also, with the radiant heat from the reverberatory furnace being reflected into the throat of the roasting chamber, there might be a tendency for the recorded temperatures at this point (as indicated by a thermocouple rod) to be higher than the actual exit gas temperature.

A Thermal Study of Autogenous Smelting in the Reverberatory Furnace—In the subsequent calculations the progress of the roasting and smelting operation will be considered as occurring in the following sequence:

1. Oxidation of part of the iron and sulphur in the feed to Fe_3O_4 and SO_2 with the exit gases assumed to contain 4% free oxygen.

2. Liberation from the furnace of the total heat lost by conduction and radiation.

3. Separation of the gases from the solids and fused material and the complete reduction on the hearth of the Fe_3O_4 to FeO, by FeS and the combination of FeO with SiO_2 to form $FeO:SiO_2$.

4. Formation of molten matte and slag.

As to the first of the operations just listed, (1), it appears most probable that under the conditions existing during the roast little Fe_2O_3 will be formed and certainly no appreciable amount of SO_3. The dissociation pressure[10] of a 10% Fe_2O_3, 90% Fe_3O_4 mixture ($Fe_2O_3 \leftrightarrows Fe_3O_4 + O_2$) is given as 0.043 atmospheres at 1,327° C. This is just above the partial pressure of oxygen in the exit gases. It will be shown that to obtain sufficently hot matte and slag the flame temperature will have to be around 1,400° C. or more. At this temperature the Fe_2O_3 mixture would have a partial pressure of about 0.25 atmospheres, which would place it in equilibrium with an exit gas containing 25% oxygen. It does not appear likely, therefore, that any appreciable amount of Fe_2O_3 will exist in the roast product.

The reason that 4% was chosen as the oxygen content of the exit gases should also be explained. A calculation made indicates that the exit gas in the Freeman pyrite burner contains about 5½% O_2 and an almost dead roast is made. In the Anaconda shaft roaster where the calcine contained from 15 to 20% sulphur the oxygen content is reported as 3.7%. In autogenous smelting a considerable amount of sulphur must be left in the calcine. At the high temperature of the flame, the reacting materials should be very active, and this excess of sulphur should guarantee that the oxygen in the exit gases will be depleted to at least 4% and will probably be nearer to 1% than to 4%.

Operation (2) actually takes place concurrently with operations (1) to (4), but by considering that it all happens at this one time it is possible to obtain conveniently the theoretical maximum flame temperature in operation (1) and also the theoretical minimum temperatures obtainable in operations (3) and (4).

As to operation (3), the reduction of Fe_3O_4 to FeO by molten FeS probably starts to take place before the calcine has actually settled on the hearth. If this happens, part of the endothermic heat of the reaction will be supplied from the sensible heat in the gases. To be on the safe side, however, I assume that the reaction takes place entirely on the hearth and that the endothermic heat of reaction is supplied by the sensible heat in the calcine.

A study of the reduction of magnetite has been made by a number of investigators.[10, 11, 12] It appears that Fe_3O_4 which has been formed from other iron compounds by low temperature reactions is in an amorphous and somewhat porous state and is easily reduced to FeO. When amorphous Fe_3O_4 is heated to redness it sinters or agglomerates to an inactive crystalline form which is difficult to reduce except at high temperatures. Magnetite found in normal copper calcine from a multihearth roaster appears to be in this form and often gives difficulty in reverberatory smelting. The Fe_2O_3 in calcine entering a reverberatory furnace appears to be easily reduced to FeO, even though Fe_3O_4 at above a red heat must be an intermediate product in the reaction. This "intermediate product" Fe_3O_4 does not appear to have had time to assume its inactive form, and it appears to be quite possible that the Fe_3O_4 formed in operation (1) and immediately reduced in operation (3) may behave similarly. However, even

if the inactive form of magnetite is formed, it should be reduced fairly completely at the high temperature existing in the flame and on the hearth.

Halferdahl,[13] who has made a study of the free energy of the reaction FeS + Fe_3O_4, states that only above 1,325° C. can an SO_2 pressure of one atmosphere or more be generated by the reacting materials. In normal reverberatory smelting it appears unlikely that the hearth temperatures ever go far above 1,250°C. In spite of this, 80 to 90 per cent of the magnetite entering the furnace is reduced. It is probably the presence of silica which allows this reduction of Fe_3O_4 at temperatures below 1,325°C. Therefore, in autogenous smelting, where hearth temperatures of 1,350 to 1,400°C. may be obtained, it is probable that the magnetite can be fairly completely reduced.

Up to the end of operation (3) the constituents in the material settling on the hearth have been considered as existing independently as single minerals, with the exception of FeO and SiO_2, which have been assumed to have combined to $FeO.SiO_2$ and generated a small amount of heat in the reaction. Now a further combination of all the oxides and silicates must be considered as occurring, the final product being the slag which comes from the furnace. A similar combination of Cu_2S and FeS to form matte must be assumed to take place at this time. As a result of these combinations, a small heat of reaction or heat of solution will likely be generated. This amount is, however, probably quite small and is not determinable, and so must be neglected in the calculations.

The heat contents of average-grade matte and slag have been determined at 1,200°C. to be 230 and 330 cal. per kg. respectively. It will be assumed that the specific heat of molten matte is 0.17 cal./kg./°C. and of molten slag 0.30 cal./kg./°C. From these data the final temperature of matte and slag can be calculated, as the total heat in the material at the end of operation (3) is known and it has been assumed that no further exothermic or endothermic reactions have occurred.

Summary of Thermal Balances Made on Autogenous Smelting in a Reverberatory Furnace—Thermal balances have been made on published figures of actual smelter feeds in three plants—namely, Noranda, Flin Flon, and Anaconda. These feeds represent three common types of copper concentrate. Noranda is typical of the low-grade type containing a large amount of siliceous flux and iron sulphides as pyrrhotite. Flin Flon feed is somewhat higher grade and may be classed as cupriferous pyrite. The Anaconda feed represents the high-grade type such as would be obtained when pure chalcopyrite was mixed with the required amount of siliceous flux to make a proper slag when smelting roasted feed.

(To be concluded)

To Determine the Niter For the Sulphide Ore Assay

A method that adds greater certainty to the guessing

R. V. Lundquist

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THE ASSAY of sulphide ores for gold and silver requires the use of KNO_3 in quantities depending on the per cent of sulphur present in the ore, to oxidize the sulphur in excess of that needed to produce a 20-gram lead button. The common method of estimating the amount of niter necessary in a fusion assay is to guess at it according to what one's experience has taught, unless a sulphur assay is available or a preliminary assay is run. Guessing sometimes causes considerable difficulty and loss of time. A method for estimating the amount of niter necessary in a fusion assay is here offered as an improved way of guessing. It is based on a knowledge of the per cent of sulphur present or a quick estimate of it.

If a sulphur assay is not available, the amount of sulphur may be quickly estimated by panning a small portion of the ore in a watch glass. By observing the amount of sulphide mineral present, its bulk can be estimated to eighths or perhaps tenths of the whole. Then, knowing the per cent of sulphur in the pure mineral, one can calculate the probable per cent of sulphur present in the ore. For instance, a pyrite ore appears to be approximately three-eighths pyrite; then the probable per cent of sulphur present would be three-eighths of 53 per cent, or 20 per cent.

In fire assaying, the oxidizing and reducing powers of reagents are expressed in grams of lead oxidized or reduced per gram of reagent used. Sulphides may be considered as reducing agents. By dividing the reducing power of a pure sulphide by its per cent of sulphur, a figure is obtained that represents the grams of lead reduced per gram of ore for each per cent of sulphur present. An examination of several of the common sulphides shows that this figure is about constant. See the accompanying table. The figures for the reducing powers are taken from the "Manual of Fire Assaying," by Fulton and Sharwood.

According to results shown in the table, each per cent of sulphur present in an ore reduces approximately 0.24 grams of lead per gram of ore. Then for ½ A.T. of ore, each per cent of sulphur present would reduce 0.24 times 14.58, or 3.5 grams of lead. This figure is very useful because it gives directly the approximate amount of lead a sulphide ore will reduce, knowing the per cent of sulphur present. By subtracting the amount of lead desired for a lead button, and dividing the remainder by the oxidizing power of niter, the number of grams of niter necessary for the fusion is given.

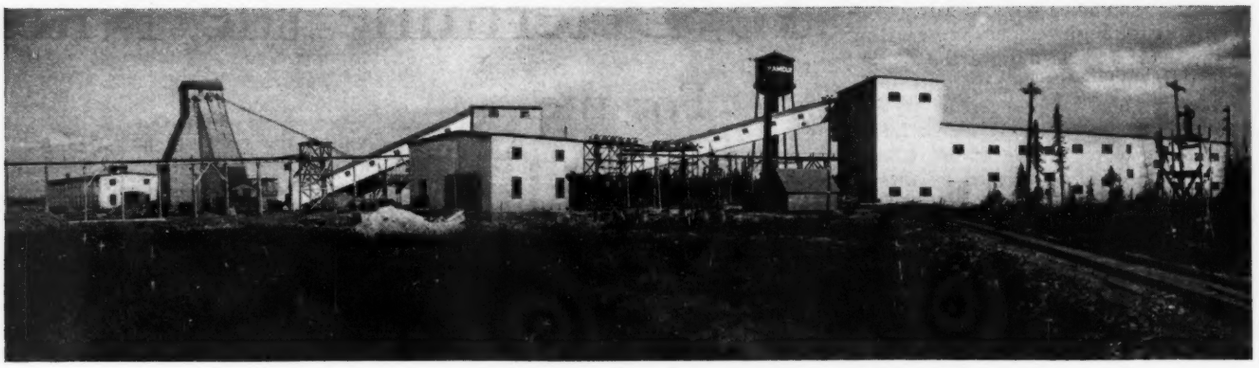
Example: To follow this method of determining the niter through, we will use the ore cited in the foregoing. This ore contains approximately 20 per cent sulphur. For ½ A.T. of ore, then 20 times 3.5, or 70 grams, of lead would be reduced if the sulphur were allowed to act to its full capacity as a reducing agent. Twenty grams of lead are desired for a lead button, which leaves 50 grams in excess. The oxidizing power of KNO_3 varies somewhat, but a suitable figure appears to be about 4.2. Then 50 divided by 4.2 gives 11.9 grams of niter needed in the charge.

For ¼ A.T., the process of calculation would be similar, except the sulphur present must be considered as half the per cent of sulphur estimated for ½ A.T., or 10 per cent. Then for this ore, 3.6 grams of KNO_3 would be required for ¼ A.T. of ore.

This method of determining the grams of niter necessary for a sulphide fusion is simple and requires only a little mental arithmetic, and a rough determination of the per cent of sulphur present, for its manipulation. It adds more certainty of success to the method of guessing.

Reducing Power of Common Sulphides

Mineral	Formula	Reducing Power	Per Cent Sulphur	Grams of Lead Reduced
Pyrite	FeS_2	12.2	53.4	0.228
Pyrrhotite	Fe_6S_7	9.7	39.6	0.245
Stibnite	Sb_2S_3	7.2	28.6	0.252
Chalcopyrite	$CuFeS_2$	9.3	35.0	0.266
Chalcocite	Cu_2S	4.4	20.2	0.218
Sphalerite	ZnS	8.2	33.0	0.248
Average				0.243



FLOTATION-CYANIDATION MILL of the Pamour-Porcupine Mines, Ltd., at Pamour, Ont., in the Porcupine district and 7 miles from Timmins. It is of 500 tons' capacity and is of noteworthy construction and equipment

Pamour-Porcupine

New Gold Producer Of Northern Ontario

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High metal price makes possible successful merger of three inactive properties

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500-ton flotation-cyanidation plant completed in May and in steady operation

A. H. Hubbell
Associate Editor

AMONG THE RESULTS of the increased price of gold and the general interest aroused in gold mining in general, and in northern Ontario in particular, is the organization and successful establishing among the ranks of producers of the Pamour Porcupine Mines, Ltd., whose property is some 7 miles northeast of the town of Timmins and the properties of the Hollinger, McIntyre, and Coniaurum companies. No attempt will here be made to present the history of the enterprise, involving the consolidation of three continuous pieces of ground constituting the holdings of the Three Nations, La Palme, and Porcupine Grande companies respectively, under a newly organized company, the Quebec Gold Mining Corporation, of which R. M. Macaulay, the moving spirit in the project, was vice-president. Financial help being subsequently needed, it was supplied by Noranda Mines, which entered the picture in the spring of 1935 and now exercises control of the present Pamour company. Of this James Y. Murdoch, of the Noranda company, is president; R. M. Macaulay, general manager; C. D. Stevenson, chief engineer; C. E. Anderson, mine superintendent; and T. R. Wearing, mill superintendent.

Holdings of the company total 1,160 acres stretching for about 2 miles east and west. Operations are confined to only part of this area, and interest at present centers on a stretch of about half a mile in length along the strike of the formations in which the ore occurs. At the west end of this stretch is the old and very small shaft of the Three Nations company, 200 ft. deep, through which the present operators went underground to begin their development work and to check the showings obtained in previous drilling, some of which had been done by their predecessors.

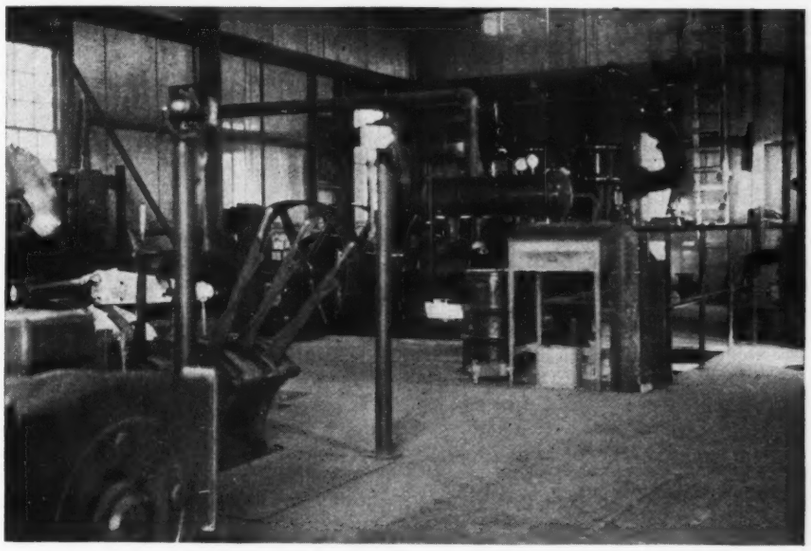
The formations strike N. 70 deg. E. and dip about 70 deg. N. Within the area now being opened, and taken from north to south, they consist of carbonated lavas, or consolidated greenstones, of considerable thickness, followed in succession by a 40- to 50-ft. agglomerate bed, some 40 to 45 ft. of graywacke and slates, known locally as the north graywacke; next a bed of conglomerate about 60 ft. thick, followed by another bed of graywacke and slates known as the south graywacke. The graywacke and conglomerate are said to be Temiskaming in age. To date, the major workings are in the conglomerate, and apparently the best values, although there is evidence of ore in all the measures. The gold mineralization is associated with quartz stringers, though only a small part of the gold occurs in the quartz. The ground is broken up into blocks by numerous north-south faults, the major ones causing a varying displacement of the conglomerate and the parallel formations laterally along the strike, which amounts to as much as 320 ft. in one of the faults a few hundred feet east of the main shaft.

Work was begun in the old shaft in October, 1935. The shaft had a very small capacity, having only a single cage, which took but a 16-cu.ft. car. From this shaft on the 200 level the new operators followed the existing crosscut north about 200 ft. to where drifting at an earlier time had been started to the east. They followed this drift east a short distance (about 200 ft.) to the point where the Three Nations workings ended, and then began the work of continuing the drift into the unopened territory to the east. This was driven to a point about 1,100 ft. east of the old

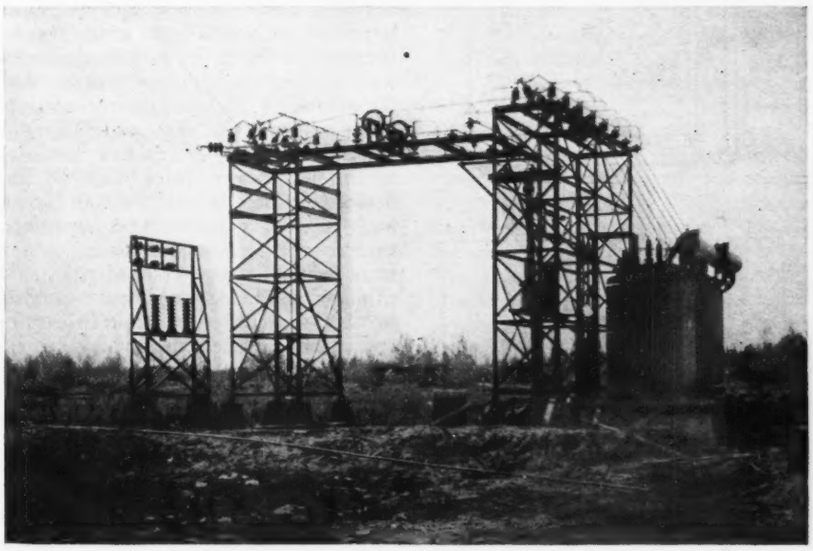
crosscut. Here they turned south and crosscut back about 350 ft. and began raising to meet a new shaft that a few months before (in July) had been started from the surface. The two shafts are only about 1,100 ft. apart, east and west, but the circuitous connecting drift and crosscuts total 1,700 ft. As soon as connection was made, use of the old shaft was discontinued. This was in December, 1935. Since then work had been greatly speeded up, more having been done in the first half year of 1936 than in all the preceding period.

The new shaft has five compartments and is 20 ft. 4 in. by 10 ft. 7 in. outside the timbers. It is sunk in the south graywacke with its long dimension at right angles to the strike. Compartments consist of two skipways for 5-ton skips in balance, one cage compartment, a pipeway and cableway, and a manway. The counterbalance for the cage runs in the pipeway. At the time of writing, hoisting is being done with a temporary hoist and headframe. Depth attained by the middle of June was approximately 700 ft. Level interval for stoping and tramming purposes is 200 ft. The 200 level had been drifted on for 1,250 ft. from the shaft, and on the west is opened to the Three Nations shaft. Besides the 200 level, the 400 level has been opened for 500 ft. east of the shaft and 200 ft. west. The station is now being cut on the 600 level. Ore and rock passes from the 200 to the 400 level have been finished.

HOIST AND COMPRESSOR PLANT of Pamour-Porcupine Mines, Ltd. It is equipped with a double-drum geared hoist, two 2,500-cu.ft. vertical reciprocating compressors, and a 420-cu.ft. horizontal unit



THE TRANSFORMER STATION that serves the Pamour-Porcupine property



Stoping has been started only on the 200 level. Here, east of the main shaft, three 200-ft. blocks have been laid out consecutively along the strike and ore breaking has begun, a block consisting of a 25-ft. pillar and a 175-ft. stope. Shrinkage stoping is employed, stoping widths varying up to a maximum of 60 ft. Likewise, north of the new shaft where the crosscut from it intersects the drift driven from the Three Nations shaft when first opening up, three stopes have been opened, two of them in the graywacke and one in the conglomerate. Here stoping widths are quite variable.

Stope development, as tentatively planned, is best seen in the second block in the conglomerate east of the shaft. Here in the ore a drift has been driven close to the footwall. From this, at 25-ft. spacing, box-hole raises have been put up along the footwall. When these are high enough to provide a 20-ft. pillar, crosscuts are driven from every other box hole to the hanging wall to provide sufficient points of attack, and a horizontal cut, 9 to 10 ft. high, is taken for the full length of the stope between the end pillars. Where the stope is wide, as in the block considered, the ore is also drifted on close to the hanging wall, and from this drift box-hole raises are put up to the sill floor at points opposite the footwall raises but midway between them. Thus, the hanging-wall raises are about 30 to 35 ft. from the footwall. Stopes are to be carried up to within 10 ft. of the level above, so that the resultant level pillar will be 30 ft. thick.

In the first stope block east of the shaft, the two drifts (footwall and hanging wall) were omitted, the box holes being put up from eight crosscuts that had been driven 50 ft. apart to sample the block at the level.

Manway raises are put up through the center of the pillars, zigzagging from wall to wall to avoid grades steeper than 45 deg., this to avoid having to timber them while driving them, as the Ontario law requires when the steepness exceeds a certain degree.

Tramming is done by hand, with 30-cu.ft. (1½-ton) cars. The skip load is limited to two cars, although the skips are of 5 tons' capacity.

About 30 rock drills of various makes are in service, six being on shaft sinking, twelve on other development, and the rest on stoping. At the time this was written, air was supplied by one 2,500-cu.ft. Bellis & Morcom compressor and a 420-cu.ft. Ingersoll-Rand unit. An additional 2,500-cu.ft. Bellis & Morcom unit was being installed, so that the number of drills could be increased. Hoisting requirements thus far have been met with a Canadian Ingersoll-Rand double-drum geared hoist driven by a Lancashire 200-b.hp. slipring induction motor. This hoist is at capacity now, and a new one is to be provided. Bucket hoisting in the sinking compartment has been handled by a smaller separate hoist.

On the strength of ore shown in the

drill holes and by development work done up to the time, a 500-ton flotation-cyanide mill was authorized late in November, 1935. Erection of the steel work was begun on Jan. 22, 1936, and the first brick was poured on May 16. In construction, the mill building is a fine piece of work. The flowsheet largely follows that of the McIntyre-Porcupine practice, although the ways of carrying it out are in part those devised by Noranda.

Briefly, the practice consists in crushing at the shaft in a jaw breaker followed by a screen and a Symons cone, the fine ore then going to a 700-ton bin. This ore is then treated by single-stage grinding in a 9x10-ft. ball mill with closed-circuit classification, the overflow being floated in Denver Sub A cells, the tailings of which are wasted and the concentrates reground in a lime circuit in a ball mill with closed-circuit agitation and classification. The ground product is thickened and given 24-hour agitation in a 0.35 per cent KCN solution, followed by countercurrent decantation and washing. The leached tailings are sent to waste and the pregnant solution is treated by Merrill continuous clarification and precipitation, the precipitate being reduced to bullion in the refinery. At the time these notes were taken, the mill had been running only a month.

About 35 per cent of the gold is said to be free (so that it is recoverable by amalgamation in a laboratory test) and the remainder is associated with sulphides. This free gold is floated. Coarse material is caught in a cone in the closed primary circuit and removed once a day. The ore contains a little pyrrhotite, which goes into the tailings in flotation, and a small per cent of arsenopyrite. Reagents used are soda ash, pine oil, and amyl xanthate.

Of the equipment used, both grinding mills are Dominion ball mills, each having a Dominion speed-reducing drive around one trunnion. The primary mill is driven by a 350-hp. motor and the concentrate grinding mill by a 100-hp. motor. Multiple V-belt drives are extensively used. The motors are Commonwealth units with NEMA frames. The thickeners preceding cyanidation are six in number and arranged in three groups of two vertically superimposed units. Each rake is equipped with an ammeter. A green signal light continues to burn so long as the driving motor is running. The two 700-ton fine ore bins are of the suspension type and are built in the mill steelwork.

Walls of the mill building have galvanized corrugated iron on the outside, followed by one inch of Insul board and on the inside of this a thin sheet of copper painted on its inner face with Waterlox. This is the inside surface.

The mill building, like all the plant, is provided with unit heaters. The entire plant is centrally heated, 60 tons of coal per month having been required last winter without any mill building to heat but with many open places where there was great loss of heat. This winter, with the mill but with few or no open places to heat, it is anticipated that coal consumption will not exceed this amount.

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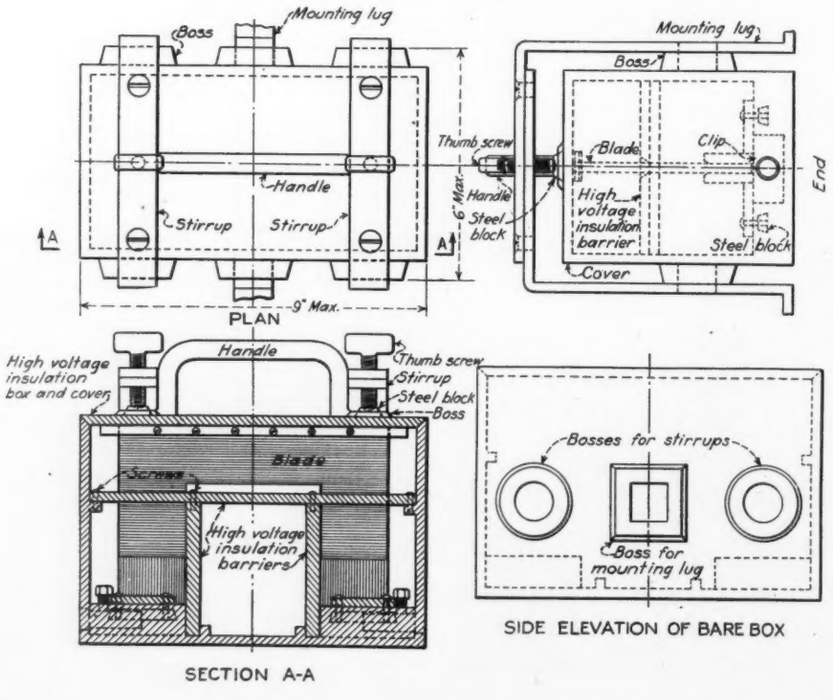
A Safe High-Tension Disconnect

SERIOUS ACCIDENTS are frequently attributable to inherent defects in the control equipment used in electric power distributing systems underground or on the surface, during a motor, transformer, or line repair job. To protect the electrician against this hazard, the current in the line section where repairs are to be made must be cut off. This is a relatively simple matter in a low-voltage system, but quite a problem from a safety standpoint when the line carries high voltage and heavy loads. The disconnect employed must be provided with every possible safety feature if a break in the current is to be effected without danger to the operator.

Total inclosure of each clip and blade, with an independent arc-quenching chamber for each clip, features this disconnect



The device developed by William H. Hart, chief electrician, and explained in detail in the accompanying cuts, has given satisfactory service at the mines of Phelps Dodge Corporation, Bisbee, Ariz. Outstanding features of the disconnect are total inclosures of the clips and blades, and an independent arc-quenching chamber for each clip. Essentially, it consists of a high-voltage insulation box, cover, and barriers, a blade attached to the roof of the cover, and four clips held by screws to steel blocks embedded in the high-voltage insulation floor. Auxiliary parts consist of a handle, two stirrups fitted with thumbscrews, which apply extra vertical pressure to the cover and thus increase capacity, and four mounting lugs. Capacities of the disconnects used at the plant are 150, 300, and 500 amp. respectively, and the voltage produced by the steam power plant is 2,400. The device is relatively small in size for the high ampere capacity and, therefore, can be used in crowded places. As it is not fused, it is employed only as a primary disconnect. All parts subject to wear are easily accessible in case of repair and replacement, and by not exposing live parts more protection is offered to the operator.

Outdoor disconnects have the lead entrance on the sides and the connectors and hood entrance holes are redesigned accordingly. Practice has shown that stirrups are not necessary for the 150- and 300-amp. sizes.

Tractors

Speed Placer Development in Alaska

EN ROUTE from Talkeetna to Peters Creek, Alaska, a 35-mile trip for the tractor over poor roads. The sleds carried each a 6- to 8-ton load and were hauled one at a time over the ice of the Susitna River

Plant designed, shipped, and transported overland to site within 75 days after examination was begun

TO EXAMINE A MINE in Alaska, discuss the report at a meeting in Idaho, design and construct a modern washing plant, ship it to Alaska, and transport it overland to the property with tractors in the middle of winter, all in 75 days, is a record accomplished by Merle H. Guise, a placer mining engineer of Alaska.

Mr. Guise was in New York in October, 1935, when clients decided to investigate a gold placer located just south of Mount McKinley, in Alaska. By flying from New York to Seattle to catch the weekly steamer for the North, and then taking a plane from Cordova to the Cache Creek district, Mr. Guise took but two weeks to reach the property. Stopping only long enough after the examination to look over some placer holdings at Fairbanks, and for a quick trip by air to examine placer ground in the Chandalar district, 150 miles north of the Arctic Circle, he reported in person to his principals at Lewiston, Idaho.

It was decided there to equip the property immediately with a dragline and modern washing plant. Plans for a large-yardage washing plant were worked out with the engineers of the Washington Iron Works, of Seattle, and an order was placed with that firm for a complete plant for delivery within three weeks. A Bucyrus-Erie dragline, equipped with 60-ft. boom and 1½-yd. bucket, was ordered, a new "40" Caterpillar diesel was shipped from Seattle, and Mr. Guise returned to the North to commence erection of the equipment as soon as the freighting was completed and the weather moderated sufficiently to carry on outside work.

Hauling 500 tons of machinery, diesel oil, and hydraulic equipment for 35 miles over poor roads and trails called for unusual methods and good organization. Manufacturers had instructions to limit the weight of single pieces to a maximum of 7 tons and the size to dimensions that would clear the Alaska Railroad tunnels. Three to six carloads of material were delivered at Talkeetna by the weekly freight, where it was unloaded by a small gasoline Caterpillar and three men. Sleds were loaded with 6 to 8 tons each and hauled singly across the Susitna River. This stream is about a mile wide at Talkeetna and required bridging where open channels appeared in the ice.

On the west bank two sleds at a time were picked up by the "40" diesel Caterpillar for the 35-mile trip to the mine. Eighteen miles out a halfway camp had been established. A cook was stationed here and another was at the main camp, on Peters Creek, 16 miles beyond. As soon as the cook at the halfway camp heard the tractor coming, day or night, he roused the waiting "cat" driver and his swamper, and prepared a hot meal for them. The rig was stopped only long enough to change crews. The tractor then proceeded to Peters Creek. As soon as the malamutes at the main camp announced by their howling its approach, the cook immediately prepared a hot meal for the crew. The tractor was halted only long enough to permit the crew to eat their meal, unhitch the two loaded sleds, and hook on two empties, before starting the return to halfway camp. This routine was continued day and night.

Seven large No. 9 logging sleds were used on this work, and a crew was maintained at the mine to unload and spot the machinery for later assembly. A towing winch was provided on the Caterpillar so that when the grades become too steep (10 per cent or more), or too icy, the tow line was hooked to the leading sled, the tractor went on to the top, where the brakes were put on, and the loaded sleds brought up the grade. This was repeated two or three times on each outbound voyage.

About 11 miles of trail was cut through the timber and brush to get up Peters Creek, as the Government roads in this district have never been completed for any practical use. The outbound trip of 35 miles was made at the rate of about 3 miles an hour, depending upon condition of the trail and depth of snow; the inbound trip in 7½ hours, or at almost 5 miles per hour. A round trip usually required from 20 to 24 hours, with an average net load of 15 tons. Double this weight could have been taken but for the grades in the hilly sections, the condition of the bridges, the temporary ice crossings on Peters Creek. About 40 gallons of 27 plus Bé. diesel oil was used in the 70-mile trip, and lubricating oil of SAE 20 rating gave perfect satisfaction in breaking in the new diesel motor. Direct operating costs, including fuel, loading and unloading, camp maintenance, and repairs to road and sleds, amounted to about $8 per ton, a figure far below any contracting rate. The freighting was completed a month ahead of schedule.

Drilling the Round

• IV •

Some Methods of Timbering

Reed E. Roberts
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MANY METHODS of timbering have been devised, and most of them are well known. Only a few will be shown here, however, including some to be used in emergencies.

Standardization of drift and tunnel sets, chutes, cribbing, lagging, ties, and the like is good practice. The timber should be framed outside if the proper equipment is not available to do it with machinery. Templets should be made and the work done by hand. The cut-and-fit method employed by many mines is slow, wasteful, and too expensive to be tolerated.

The first method illustrated is that of driving spiling. This can be done so that it is a workmanlike job when completed, and not so botched up that it is an eyesore. When ground is encountered that caves or runs so badly that it necessitates spiling, a standard set should be put in as illustrated in Fig. 24. The spiling should be framed with sufficient bevel at the point to facilitate driving it. A heavy ram or hammer should be used; preferably a ram, as it does not split the spiling so badly.

Fig. 24 illustrates driving spiling where the back only is soft and runs. Many mines drive spiling without a bridge piece. Spiled ground, however, is very heavy and needs repair more often, and the bridge method gives more headroom if an additional set is needed. It also serves as a guide for starting to drive the next spile. The size and length of spiling and the spacing of sets depend entirely on the weight of the ground and the strength of the timber. This must be determined by conditions.

When ground runs on the face and sides of a drift the same method should be used on the sides as is employed on the backs. Breast boards should be used on the face, as illustrated in Fig. 25. First, the back spiling is driven in, if possible, past the point where the next set of timber is to stand. If this cannot be done, due to striking large rocks, some of the ground should be worked out until a boulder or large rock drops down, and then the spiling should be driven in. Next, the side spiling is started at the top and the boards are worked in to a point where the next set is to be placed. Several side spiling should be worked in on each side until the sides are lagged up 1 ft. or more. Then one should begin to take the muck out from the top, not from the bottom. As soon as enough muck is removed, a lagging should be cut that will just fit in between the side spiling. This should be wedged tightly, as shown. This operation should be continued until sufficient is out for the next set. This work is slow and tedious. A single slip may mean that all the work has to be done over again. Care must be taken not to take out too much ground at once without securing it.

In some ground timber has to be kept up to face at all times. After a round is fired in a heading, that piece

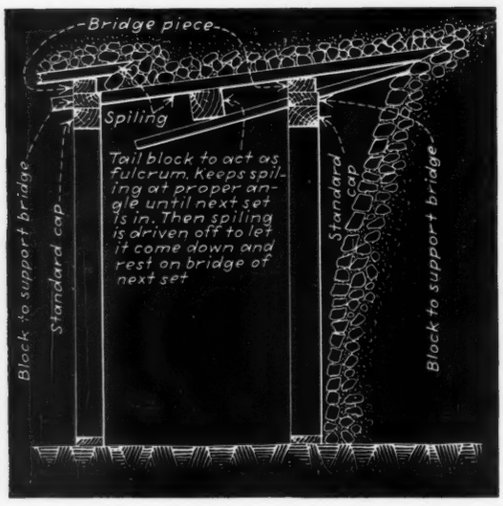

Bridge piece
Spiling
Tail block to act as fulcrum. Keeps spiling at proper angle until next set is in. Then spiling is driven off to let it come down and rest on bridge of next set
Block to support bridge
Standard cap
Standard cap
Block to support bridge

Fig. 24 . . . STANDARD SPILING as used when the back only caves or runs badly. The use of a bridge piece gives more headroom if an additional set is required

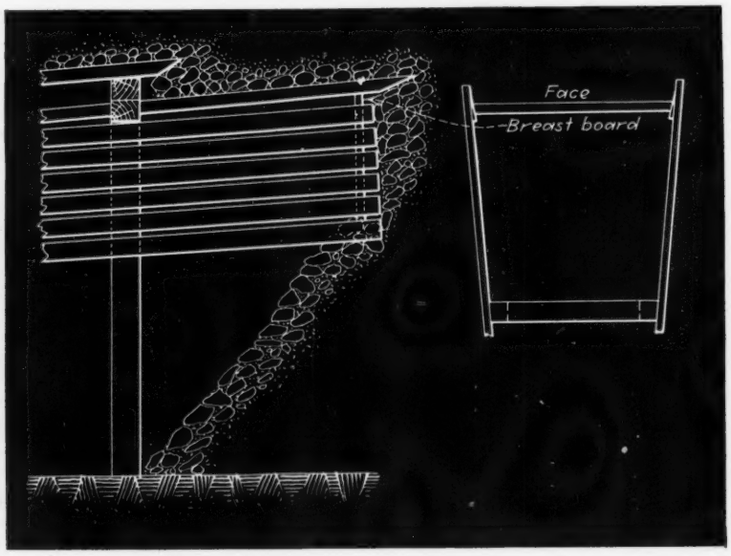


Fig. 25 . . . SPILING as used when both the face and sides of a drift run so badly as to call for this procedure. Breast boards are used on the face as shown

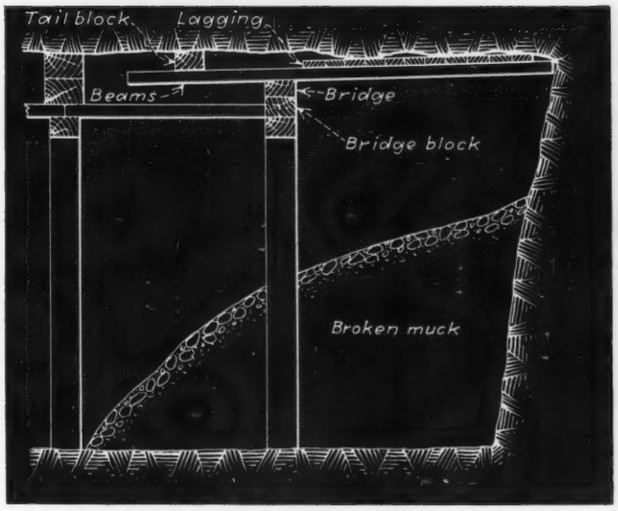


Fig. 26 . . . BOOMS may be used where the timber has to be carried close to the face at all times. The back is thus supported while the muck broken in the round just fired is being removed and the next round drilled

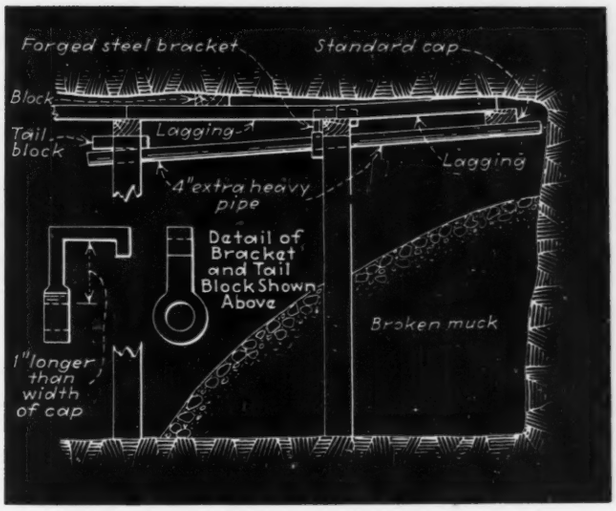


Fig. 27 . . . THE BOOMING METHOD shown here is fast and cheap because of the equipment used. This consists of three lengths of pipe, three steel brackets, and three tailblocks. The procedure is explained in the text

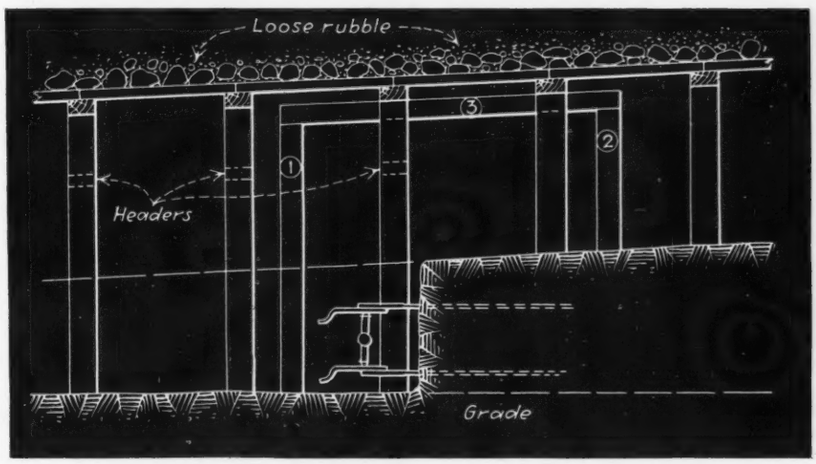


Fig. 28 . . . TAKING UP BOTTOM in a timbered drift where the back is loose and runs can be done faster and more cheaply by the method shown than by drilling down holes with jackhammers

of ground is open. It is necessary to hold the back up until the muck is cleaned out and the next round drilled. To do this necessitates the use of booms. Figs. 26 and 27 illustrate the practice. Fig. 26 shows the method usually employed. The back has to be carried higher; consequently more muck is handled and much more timber is required. Number and size of beams are determined by the weight of the ground to be supported. The ground must be studied carefully to make sure that the booms are strong enough to hold any weight required of them. Usually, the procedure is to use two beams, but in very heavy ground three are safer.

The method illustrated in Fig. 27 is much faster and cheaper than that shown in Fig. 26. Equipment consists of two or three 4-in. extra-heavy pipes 12 ft. long, three forged steel brackets, and three tailblocks. The brackets should be made of 2.5 x 3-in. steel stock. Notches should be cut in the lagging so that the brackets can be hooked over the cap; the pipe should be pushed through the holes in the brackets until it reaches the face; the cap and lagging should then be set and the tailblock put in. The beams are now raised approximately 6 in., as shown, where the next set is to be placed. The next round is drilled, mucked out, the posts are set in place, the tailblocks knocked out, and the cap is let down on the posts. Then the set is blocked securely, the pipe removed, and the round blasted.

A method for taking up the bottom in a timbered drift where the back is loose and runs is illustrated in Fig. 28. It has been found cheaper and faster than the method usually employed—namely, drilling down holes with jackhammers—and makes it easier to maintain the grade.

Two posts, Nos. 1 and 2, should be cut the proper length. Post No. 1 is set far enough back to give room for the machine. Post No. 2 is placed far enough forward to avoid disturbing the bottom when the round is blasted. Stringer No 3 is placed on the posts and wedged up tightly to the cap. All lagging is placed securely. The horizontal bar and drill are set up as shown. The round is blasted lightly, just enough powder being used to shake up the ground. Then dirt is mucked out and new posts are set. If the ground is very heavy, headers should be put in, as shown, to support the posts.

In conclusion, I would add that by organizing the crews and paying a bonus to the men who make the best progress without accident, an incentive is created for the men to do better work. This bonus will be a very small percentage of what will be saved, but will mean a lot to the men who get it, both as a monetary reward and in pride of achievement.

Correction—In Part III of this article, published in the September issue, the author was made to say, through no fault of his, that "iron or steel should be used in tamping a hole." The negative was accidentally omitted in editing his manuscript. Iron or steel should never be used in tamping a hole, as every competent miner knows.

●

Shutter for Cable Opening

IN ZERO WEATHER in the hoist room the opening where the cable passes through is the cause of much draft, writes Charles Labbe, of Goldfield, Nev. As a remedy, various ways of closing the opening have been devised. Two pieces of belting or canvas nailed on the outside are most common. From experience Mr. Labbe prefers a light piece of board free to slide back and forth from slight friction of the cable, the rope passing through a small hole in the board.

Electrolytic Manganese

. . . Its Potentialities Loom

High-grade metal made by continuous deposition in experiments conducted with four domestic ores and reagents of commercial purity

J. Koster and S. M. Shelton

Supervising Engineer and Associate Metallurgist, respectively, Electrometallurgical Section, Metallurgical Division, United States Bureau of Mines, Reno, Nev.

MANGANESE is one of the most important of the strategic metals. Large manganese-bearing deposits have been discovered and developed in well-distributed domestic localities, but the United States has depended almost exclusively on foreign sources for manganese ores. This is well illustrated in the graph, which is taken from the chapter, "Manganese and Manganiferous Ores," by Robert H. Ridgway, in *Minerals Yearbook, 1936,* United States Bureau of Mines.

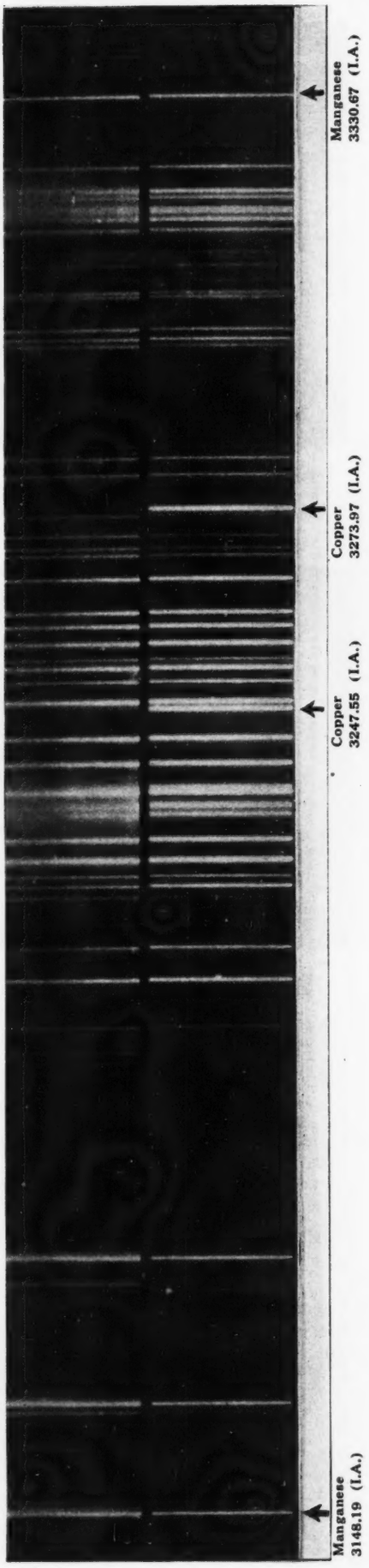
Approximately 95 per cent of the manganese used is consumed in the iron and steel industry, largely in the form of ferromanganese. Ore suitable for the production of this alloy is required to meet rigid specifications. For example, prices are frequently based on not less than 40 per cent metallic manganese, not more than 8 per cent silica, and not more than 0.2 per cent phosphorus, with an allowable ratio of iron to manganese approximately 1 to 10. If the ore contains small quantities of zinc or sulphur, it is penalized or even rejected.

American manganese deposits are widely distributed and vary in composition. Deposits containing 10 to 45 per cent manganese are not uncommon, but due to failure to meet one or more of the specifications, only small tonnages of metallurgical or furnace ores are available.

Beneficiation of domestic ores has been attempted repeatedly, and in some cases with admirable results, but due to chemical or physical properties, the quantity of domestic ore suitable for dressing in competition with directly mined foreign ore is definitely limited. During the World War, many of the domestic deposits were worked for the production of metallurgical-grade ore, but as soon as normal trade was resumed, domestic production dropped to relatively small importance.

Numerous leaching processes have been devised, and it is safe to say that the hydrometallurgy of manganese and the production of relatively pure solutions of manganese have been well established. However, there is no economical method for recovering the manganese from the leach liquors. Most of the processes so far developed involve the dissolution of the manganese minerals from the ores by means of sulphurous acid or ammonium sulphate. The liquors are then put through various purification processes, the final product being a rather pure solution of manganese sulphate. The salt can be crystallized from solution and then calcined to drive off the sulphate radical, or it may be chemically precipitated as the carbonate or some other insoluble form and subsequently calcined. The product is a manganese oxide which must be sent to a ferro-alloy furnace for a further expensive reduction before it is ready for use.

Electrolysis presents itself as a logical method for removing manganese from solution. There is no reason to believe



SPECTROGRAMS obtained upon examining samples of manganese deposited on copper (right) and on iron (left) with a Littrow-type spectograph

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that manganese cannot be economically recovered by electrolytic means. Domestic manganese ores which contain 5 to 40 per cent of the metal compare favorably with ores worked for zinc or copper, and electrolytic manganese should be a more suitable product for all purposes than are the industrial manganese alloys now available.

The steel manufacturer pays a high premium for low-carbon ferromanganese. The current price for low-carbon ferromanganese containing less than 2 per cent carbon is of the order of 7½c. to 10c. per pound of contained manganese. Standard 5 to 8 per cent ferromanganese now sells for about 5c. to 5½c. per pound of contained manganese. Pure manganese metal for the manufacture of special bronzes and other alloys where iron is to be avoided commands about 40c. per pound.

The greatest proportion of manganese, of course, is consumed in the form of standard 5 to 8 per cent carbon ferromanganese; consequently, electrolytic manganese ultimately would have to compete in price with that product. That is, electrolytic manganese must be produced at a cost range of 5c. to 5½c. per pound for domestic ores to replace entirely foreign ores in the American iron and steel industry. By rough comparison with electrolytic zinc costs, this does not appear to be an unattainable figure. However, it seems reasonable that there should be a definite market for carbon-free, high-purity manganese, particularly in the manufacture of high-manganese alloy steels, and in non-ferrous metallurgy, at a price range of 10c. to 15c. per pound.

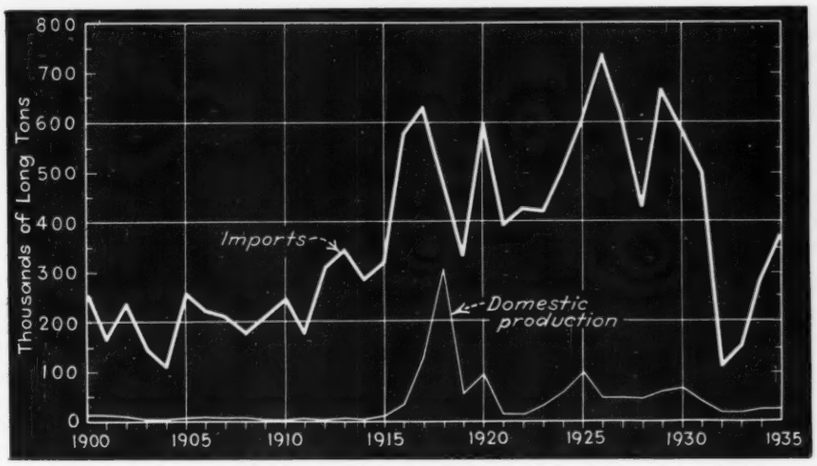
Potentialities of an American manganese industry are enormous, provided that an electrolytic process can be satisfactorily developed. The desirability of a domestic source of supply in any emergency needs no elaboration.

Present development of cheap electric energy in the vicinity of the manganese deposits of Nevada and Arizona, and of the newly discovered deposits in the Pacific Northwest, offers a means of economically using available energy to produce a desirable product which will compete only with foreign sources of supply.

The United States Bureau of Mines in the recently established Electrometallurgical Section of its Metallurgical Division has undertaken a study of methods for the electrolytic recovery of metallic manganese from domestic ores.

The electrodeposition of manganese is not new. R. Bunsen[1] probably first obtained electrolytic manganese. He used platinum electrodes and an aqueous electrolyte of manganese chloride. Many reports have been added to the literature of electrolytic manganese since then. Notable examples are the researches of Smith and Frankel[2], Van Arsdale and Maier,[3] Fedotieff,[4] and Allmand and Campbell.[5]

Manganese has been produced from different electrolytes in small quantities and various degrees of purity. Apparently, the chief difficulties have been that either the acidity increases to such a point during the electrolysis that the manganese is redissolved as fast as it is deposited, or, unless conditions are carefully maintained, hydrated oxides of manganese form on the anode and foul the electrolyte. No record has heretofore been found of a continuous electrolytic deposition of metallic manganese in amounts of more than fifty grams.



MANGANESE ORE imports and domestic production of manganese ore, 1900-1935. Figures used for imports represent "general imports" for 1900-1933. Beginning with 1934, data classified as "general imports" were not available, and the figures plotted for 1934 and 1935 represent imports for consumption adjusted for changes in stocks in bonded warehouses, and are closely comparable with the record for earlier years

Present Work on the Electrodeposition of Manganese—To cope with possible difficulties that might be met in large-scale operations and to simulate to some degree conditions that might occur in leach liquors from actual ores, reagents of "technical" or "commercial" purity were used for the work.

Numerous preliminary experiments were made in which the work of previous investigators was frequently repeated. Electrolytes containing only manganese sulphate gave non-metallic deposits on the cathode. Electrolysis of solutions containing manganese sulphate and either ammonium sulphate or chloride resulted in gray metallic deposits at current densities above 100 amp. per square foot. The electrolyte fouled and the cathode turned black after a few minutes' plating time.

A diaphragm was placed between the cathode and the anode; manganese carbonate was added in excess to the electrolyte of manganese and ammonium sulphates. The anolyte was agitated to keep manganese carbonate in suspension to react freely with the sulphuric acid formed. Manganese of 85 to 95 per cent purity (the remainder oxygen) was deposited on the cathode continuously for periods as long as 72 hours' plating time, but invariably the surface of the deposit was rough, and eventually nodules and "trees" formed, which caused the rate of deposition to drop gradually to zero.

It was found that manganese of 99.6 to 99.85 per cent purity could be deposited under similar conditions, provided that the sulphite ion was present in the catholyte in concentrations of the order of 0.1 gram per liter. The sulphite ion can be added as ammonium sulphite, sulphurous acid, or sulphur dioxide gas introduced directly. Satisfactory deposits of high purity were obtained in the presence of sulphite ion with pH values between 4.5 and 8. The tendency to form nodules seems to be at a minimum when the pH lies between 6 and 8.

Continuous Electrolysis—In view of the successful deposition of manganese of 99.8 per cent purity under the conditions recorded, it was decided to devise a circulating system suitable for continuous deposition. The system consisted of a wooden electrolytic cell containing in the center a sheet-steel cathode 4 x 10 in. Two sheet-lead anodes of the same size were placed one on each side and parallel to the cathode. Wooden storage-battery separators served as diaphragms between the cathode and the anodes. The electrolyte flowed up and around the cathode, over the top of the diaphragms into the anode space, then

[1]Pogg. Ann., Vol. 91, 1854, p. 619; Ann. Chim. Phys., Vol. 41, 1854, p. 355.

[2]Smith, E. F., and Frankel, L. K.: *Jour. Anal. Chem.*, Vol. 3, 1889, p. 386.

[3]Van Arsdale, G. D., and Maier, C. G.: *Trans. Amer. Electrochem. Soc.*, Vol. 33, 1918, p. 109.

[4]Fedotieff, P. P.: *Zeit. anorg. chem.*, Vol. 130, 1923, p. 18.

[5]Allmand, A. S., and Campbell, A. N.: *Trans. Faraday Soc.*, Part I, Vol. 19, p. 359; *ibid*, Part II, Vol. 20, 1924, p. 379.

to a tank equipped with a wooden stirrer, then to a settling tank, and finally back into the cathode compartment again; SO_2 gas was added to the catholyte during plating.

After proper conditions had been established, manganese could be continuously deposited, apparently indefinitely. Operation data on a typical run are given in Table I.

A direct analysis of the deposit showed 100.15 per cent manganese. Analysis for impurities showed only iron to the extent of 0.15 per cent, which gives 99.85 per cent manganese by difference.

Leaching of Manganese Ores—The success of the 40-liter system in continuously producing high-purity manganese metal indicated that a larger set-up was desirable and that electrodeposition from solutions obtained from actual ores should be attempted.

Samples of manganese ores from several different localities were obtained. So far, only four of them have been used in the leaching work. These are designated as follows: Golden Eagle, Pioche, Nev.; Caselton, Pioche, Nev.; Crescent, Olympic Peninsula, Washington; and Three Kids, near Las Vegas, Nev. The samples were presumably representative of the orebodies from which they were taken. Their analyses are given in Table II.

Leaching was carried on in a 15-gal. barrel equipped with a wooden stirrer. Water and crushed ore were placed in the barrel and sulphur dioxide passed into the solution by a lead pipe. When extraction had reached an efficient maximum, as determined by either chemical analysis or hydrometer tests on a filtered sample, the pulp was allowed to settle and the liquor was decanted from it.

As shown by Table III, the leach liquor of the Golden Eagle ore was high in iron and that of the Caselton ore high in zinc. Both iron and zinc are precipitated with manganese when ammonium carbonate is added. The leaching properties of the Crescent ore have not yet been investigated.

The most satisfactory solution for the immediate purpose of electrolysis was that made from the Three Kids ore. Consequently, it was decided to use that ore for the first experiments, with a larger set-up.

Continuous Electrolysis of Manganese From Leach Liquors—Manganese contained in the sulphate leach liquor was precipitated with ammonium carbonate. The manganese carbonate sludge was added to the larger circuit to replace manganese removed from the electrolyte by deposition.

The larger closed system consisted of a cell which contained a cathode of 1.7 square feet plating area with diaphragm (storage-battery separators of wood) spaced two inches from the cathode on both sides. Sheet-lead anodes were spaced one inch away from the diaphragms. Two 25-gal. barrels with wooden stirrers were used as agitation tanks. Two lead-lined settling tanks were constructed; one was 1x1x9 ft. long, the second was 1x1x4 ft. long. A woolen-cloth screen was placed in the second tank to filter the solution before it entered the cell. The electrolyte entered the bottom of the catholyte space in the cell, flowed over the diaphragms to the anolyte spaces, and then to the first agitation tank, where it came in contact with fresh manganese carbonate added at intervals as a sludge. The electrolyte flowed to the second agitation tank, where the reaction between manganese carbonate and acid formed during the electrolysis was completed. From the second agitation tank, the electrolyte flowed through the larger, then the smaller settling tank, and back to the cell to complete the circuit; SO_2 gas was added continuously to the anolytes.

Iron, low-carbon steel, copper, and aluminum were tried as cathode starting sheets. The manganese plated readily to the copper and aluminum, and less readily on iron and steel. Adherence to the copper was too great for stripping. Deposits on aluminum, iron, and steel were stripped satisfactorily.

Data of a typical test deposition are listed in Table IV.

As shown by Table IV, continued electrolysis for long periods leads to a rough nodular surface. The rough surface is very detrimental to current efficiency. Current efficiencies as high as 70 per cent were obtained under

(*Continued on page 514*)

Table I—Operating Data on a Typical Run in the Circulating System

Electrolyte constituents:	
Manganese sulphate, grams per liter	80
Ammonium sulphate, grams per liter	150
Manganese carbonate	To saturation
Total capacity of system, liters	40
Rate of circulation of electrolyte, liters per hour	10
Total time of operation, hours	48
Current density, amperes per square foot	33
Potential across terminals, volts	5
Total manganese deposited, pound	0.6
Average current efficiency, per cent	55
Kilowatt-hours per pound of manganese	4.1

Table II—Analyses of Manganese Ores

Constituents	Per Cent			
	Golden Eagle	Caselton	Crescent	Three Kids
Mn	6.77	10.73	44.00	32.10
Fe	15.25	11.95	1.48	0.68
Pb	1.47	8.95	nil	1.54
Zn	2.20	2.80	nil	nil
SiO_2	39.22	31.40	15.86	17.38
$CaCO_3$	14.53	6.67	13.06	0.09
$MgCO_3$	0.84	0.75	0.61	3.56
Gold, oz. per ton	0.17	0.075	....	....
Silver, oz. per ton	3.10	12.93	....	....

Table III—Analyses of Leach Liquors in Grams per Liter

	Golden Eagle	Caselton	Three Kids
Mn	34.6	61.25	72.0
Fe	10.8	0.90	0.11
SO_3	0.85	1.4	1.3
Pb	.....	Nil	Nil
Zn	.....	8.43	Nil
Cu	.....	Nil	Nil
Ca	.....	0.69	(a)
Mg	.....	0.22	Nil
As	.....	.....	0.06
Al	.....	.....	(a)

(a) Indicated in small amounts by qualitative tests.

Table IV—Manganese Deposition Data

TEST 78

Electrolyte Analysis	Grams per Liter
$MnCO_3$	To saturation
$MnSO_4$	84.0
NH_4SO_4	139.0
SO_3	0.022
Mg	0.98
Fe	0.001
Al	0.002
Cu	0.004
Pb	Nil
Total capacity of the circuit, liters	450
Catholyte flow rate, liters per hour	84
Current density, amp. per sq.ft.	28.2
E.M.F., volts	5.6
Continuous plating time, hours	48
Manganese deposited, pounds	2.59
Current efficiency, per cent	51.1
Rate of power consumption, kw.-hr. per pound manganese	4.98

"Armco" iron cathode.

Description of deposit: Metallic, 99.8 per cent Mn; surface, rough nodular; corners and edges, black. Definite indications of polarization.

Table V—X-ray Data

Data by A. J. Bradley (a)				Present Investigation		
Beta Manganese,		Gamma Manganese,		Electrolytic Mn		
d/n	Intensity	d/n	Intensity	d/n	Intensity	Modification
2.083	V S	2.086	V S	2.087	10	Beta + Gamma
		1.977	V S	1.981	4	Gamma
1.886	M	1.886	S	1.889	2	Beta + Gamma
1.807	M W			1.809	½	Beta
1.737	M			1.745	½	Beta
		1.679	W M	1.673	½	Gamma
		1.481	W M			
		1.404	W			
1.341	V W					
		1.329	V W			
1.283	W M					
		1.234	S	1.231	½	Gamma
1.256	W M					
1.212	S	1.213	W	1.199	1	Beta + Gamma
1.190	W					
1.169	W	1.169	S	1.171	½	Beta + Gamma

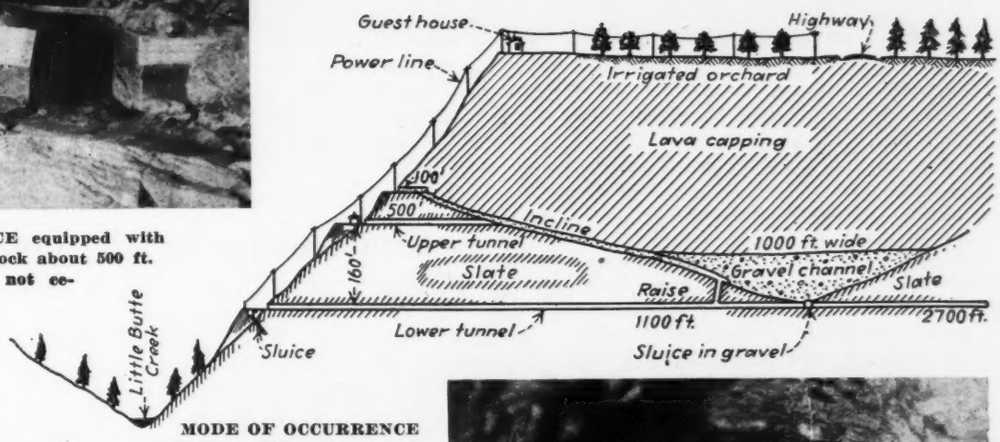
V S —very strong
M —moderate
V W—very weak
S —strong
W—weak

(a) *Phil. Mag.*, Vol. 50, Ser. 6, 1925, p. 1028.

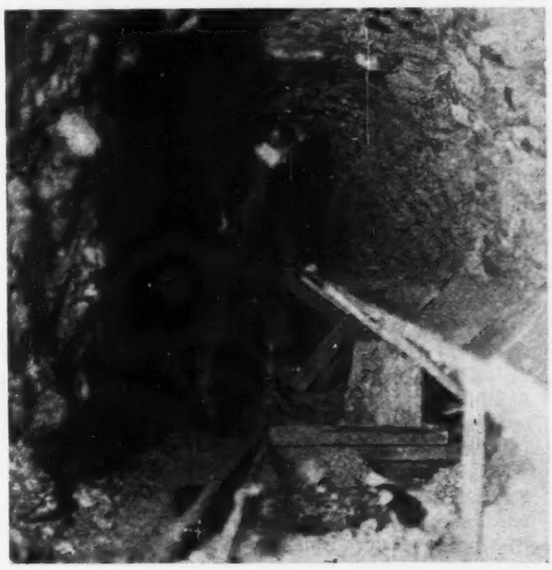
Washing Gravel Underground

AT LUCKY JOHN

THE UNDERGROUND SLUICE equipped with iron riffles rests on slate bedrock about 500 ft. underground. The gravel is not cemented but tightly packed and is blasted by 20 per cent powder



MODE OF OCCURRENCE of the gold-bearing gravel deposit and the underground development in cross-sectional sketch. Part of the upper deposit has been mined along the incline and boulders are dropped into the raise and hauled to the dump. The lower sluice will afford operation on a larger scale



THE INCLINED V-FLUME, which conveys gravel from the sluice boxes to a winze from which the washed rocks are drawn from a chute and trammed to the waste dump

Gold-bearing deposit trapped between lava and shale is exploited by blasting and flushing into sluice boxes

Glenville A. Collins

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THE LUCKY JOHN drift-gravel mine is situated in the Magalia mining district, in Butte County, Calif. The property covers 320 acres facing Little Butte Creek, and has produced intermittently for about 50 years. Work done in the early 'eighties included a 2,700-ft. tunnel driven into the mountain from the south bank of Little Butte Creek under the bottom of an ancient river channel from which gravel was washed until the portal was closed by a heavy slide. The workings remained idle for nearly 40 years. Operations were resumed in 1923, and an upper tunnel was driven a distance of 400 ft., which intersected a branch gravel channel. Subsequently, an incline was started down this channel, but difficulties as to pumping, ventilation, hoisting, mucking, and maintenance of a track grade over a rough and rolling bedrock, resulting in excessive costs, soon stopped the undertaking. Nevertheless, about $80,000 was reported to have been recovered from these workings.

The property was acquired by a new company in 1933, and preliminary mining operations were centered in the reopening of the lower tunnel mentioned previously. In shifting ground, composed of slates at a point where springs flowed, this proved to be a tedious task. After months of work, employing spiling and heavy timber, the tunnel was opened and cleaned out a distance of 2,000 ft. At a point 1,100 ft. from the portal of the tunnel, a raise was run 100 ft. high and a drift started following the bedrock of the branch channel to connect with the incline sunk from the upper tunnel. Completion of this work provided a means of drainage, made accessible the branch channel, and gave excellent ventilation and a dual exit. Next, the operation of mining in this part of the property was worked out in the following manner: A V-shaped flume was installed from the top of the 100-ft. raise up the 8-deg. incline on bedrock to the upper tunnel, a distance of about 600 ft. Water flowing from different workings on the upper tunnel level was dammed off by a concrete bulkhead, thus forming a reservoir containing 150,000 gal. A 4-in. pipe line laid down the incline and fitted with valves provides water at numerous points along the flume.

Mining of the gravel was laid out on a room-and-pillar system, using a room about 10 ft. wide and leaving a gravel pillar 20 ft. wide. The gravel, overlain by about 500 ft. of overburden consisting of lava, is tight but not cemented. It requires blasting, which is done with 5-ft. holes and 20 per cent powder. A face is first blasted down into a sizable gravel pile and then flushed into a section of sluice leading into the V-flume by a 3-in. hose connected to the main water line. The flume in turn carries the

washed gravel to the top of the raise chute. Accumulated material is drawn at the bottom of this chute into mine cars and trammed through the lower tunnel to the waste dump. The ditch running alongside the track drains all water from sluicing operations. Boulders more than 3 or 4 in. in diameter encountered in the broken gravel are packed into the openings made in the stopes, and smaller ones are taken up on a fork. The labor expense for disposing of oversize material and boulders, which represent about 30 per cent of the gravel mined, is relatively small. By employing this system it is possible for one man to wash away about 10 yd. of gravel per hour, compared to one full shift under the old system of mucking into cars and hoisting the gravel to a washing plant on the surface, with two miners and a hoistman employed.

The room system is staggered. A machine man with a helper completes a round of holes in about three hours, then blasts, and immediately proceeds into a neighboring chamber to repeat the blasting cycle just completed, thus putting in two complete drill rounds in one shift. During the shift these men also wash the gravel into the sluice boxes and dispose of oversize material and large boulders. Total production per shift is about 20 yd. of gravel. Work on the surface, such as tending the compressor, sharpening detachable bits, and general chores, is done by one man. The advantages offered by the mining method described are elimination of tracks and cars and hoisting equipment.

The sluice-box sections are made from 12-in. boards, and all are equipped with iron riffles. Because of their flexibility they can be used over rough rock or in angular positions, and being installed underground and under constant supervision, "high-grading" is reduced to a minimum. On a daily production of 50 yd. of gravel, the total cost of handling gravel in the manner described is about 70c. per yard. This figure can be materially reduced when operating on a larger yardage basis.

The second stage or main operation at the Lucky John mine will be from the bottom of the main channel which is intersected by the lower tunnel at a point 1,900 ft. from the portal. At this point the gravel stream is nearly 500 ft. wide. Preparations are being made to mine the deposit in a manner similar to the one described, but with some modifications. A main drift is being driven up the sump of the channel so that a sluice installed on the floor of this opening will be about even with the bedrock level. Staggered rooms 20 ft. wide extending back up the slope of the bedrock will be mined. These may be several hundred feet long, as broken gravel will be removed through a portable flume discharging into the main sluice box at the sump of the channel. Pillars about 50 ft. wide will be left between rooms. Removable 4-in. pipe lines will be available in each chamber. Boulders will be left in the rooms, and the discharge of the sluice box will be directed into a short raise chute, from which the material can be loaded into cars and hauled by a mule in trains of five cars to the tunnel portal.

The gravel is in many instances 20 ft. thick, but stands well if mined only 10 ft. high. The bedrock is slate, and most of the gold particles are found near the bedrock. With a production of 300 cu.-yd. of gravel a day, the total cost is expected to be 50c. or less per yard of gravel mined. Water is piped into the mine from an irrigation system 600 ft. above the tunnel level. No attempt has been made to mine hydraulically, but, after some experimentation, it is believed possible under the high pressure available. So far the gravel is blasted down and hydraulicked into the sluice boxes.

The Lucky John channel is being exploited from the lower end of the property, and nearly a mile of gravel channel extends upstream from the intersection of the lower tunnel. Frequent branches have been identified which can be mined by the method explained previously. The gold recovered is quite coarse and of about 875 fineness.

The Lucky John property is controlled by the Silver Bell Consolidated Mining Company, of Pittsburgh, Pa. The work is under my supervision.

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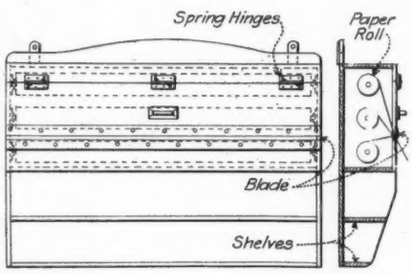
Convenience for the Drafting Room

A SIMPLE PIECE of equipment that makes possible proper storage and quick and easy cutting of drawing and tracing paper has recently been developed at the engineering office of the Phelps Dodge Corporation, Copper Queen Branch, Bisbee, Ariz. In most offices the rolls of paper are kept in circular casings stored on shelves or in the drawer of the drawing desk. Much time is lost in unwrapping the rolls, and severance of a piece of paper for the drawing board is always a cumbersome task.



Blunt cutting tools cause uneven edges and frequent spoilage of paper. These difficulties can be overcome by the installation of the shelf shown in the accompanying sketch. It is built of wood and essentially contains a dustproof storage chamber for paper rolls and two open shelves for books or drawing implements. The rolls proper rest in simple bearings secured by screws to the side walls of the shelve, and severance of paper is effected by a cutter or blade attached to the lid of the storage chamber pressed to the lower front wall by three spring hinges.

Electrolytic Manganese

(*Continued from page 512*)

identical conditions, but with shorter periods of plating time.

The causes of surface roughness and polarization found in the larger circuit are being traced by changes in concentration, current density, and other variables and by spectroscopic analysis for impurities.

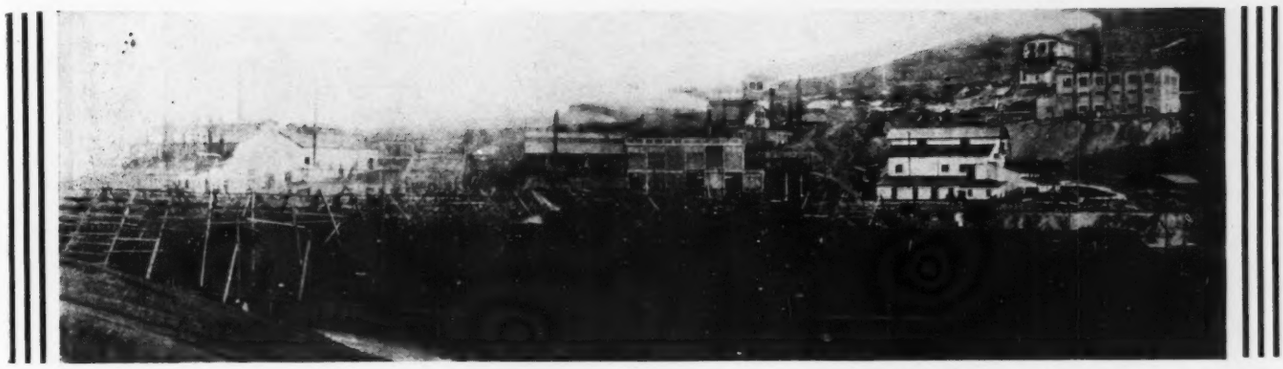
Analyses of Electrolytic Manganese—Electrolytic manganese deposited from sulphite-containing electrolytes has been consistently above 99.6 per cent pure. The principal impurity is the metal of the starting cathode.

Samples of manganese deposited on copper and on iron were examined spectroscopically. Spectrograms were taken with a Littrow-type spectrograph. Carbon electrodes purified by prolonged acid treatment were used. The spectrogram on the left is from manganese deposited on iron and that on the right is from manganese deposited on copper. Copper shown in the latter is practically absent from the former. Iron lines are not found in the portion of the spectrum shown.

A sample of the manganese plated on copper was analyzed for impurities identified by spectrum lines and gave the following results. Cu, 0.045; Fe, 0.02; Al, 0.02; Zn, not detected; and Mn, 99.91 by difference.

X-Ray Examination of Electrolytic Manganese—A solid piece of the metal was mounted so that an edge was in the beam of an iron target, and a satisfactory pattern was obtained. Measurement of the spectrogram showed the presence of lines due to both beta and gamma manganese. Interplanar spacings for these two modifications of manganese, together with the values obtained in the present investigation, are presented in Table V.

The authors gratefully acknowledge the assistance of A. C. Rice, Reno, Nev., for the spectroscopic work, and of M. J. Haug, Rolla, Mo., for X-ray work.



THE LARGE BUILDING in the upper center contains the roasters, and the smelter is directly below. The white building to the left is the refinery. On the hill to the extreme right is a chateau-like "Cottrell House." The boxlike building below this is the baghouse. The white triple-roof structure contains hearth roasters and equipment for making sulphuric acid.

SOVIET RUSSIA LOOKS to these buildings for more lead and zinc. As development of the Ridder mines reveals larger reserves, greater ore-smelting facilities are planned

The Metalliferous Altai Of Soviet Russia

•IV•

Metal recovery in smelting practice will increase as young Russian engineers acquire more practical experience

Andrew Meyer and Edith Meyer
Mining Engineer *Metallurgical Engineer*

DESCRIPTION of the Ridder smelter would be laborious if an attempt were made to cover all the tedious methods involving hand labor, but some odd analyses must be mentioned. The accompanying reproductions of photographs illustrate some of the various phases of smelting practice and the equipment available. The photograph above shows the general layout of the buildings. Behind the center group of structures is the point at which the railroad from the mill connects with the concentrate and flux bins, and it is at this point that the fourth and concluding installment of our article begins.

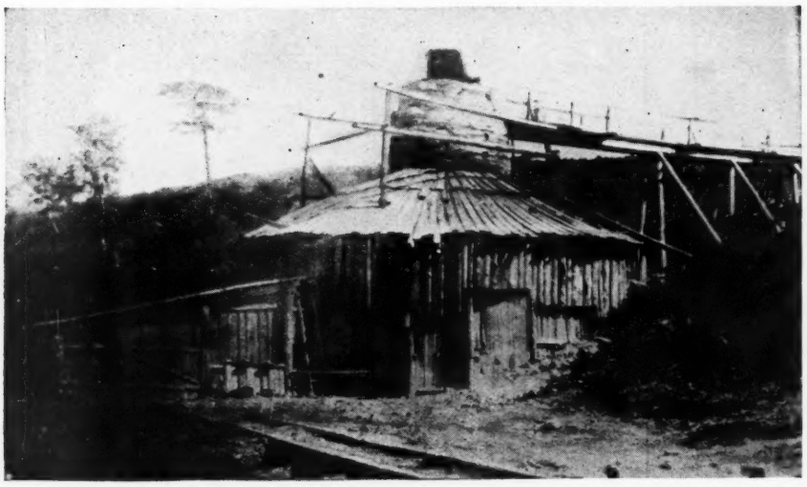
The charge, sent to the roasters from these bins, is shoveled into the small cars. The concentrate—frozen or otherwise, and containing limestone, iron ore, and quartz ore—is sent to a small Blake crusher, which crushes to 10 to 20 millimeters. This material is passed via bucket elevator to a disintegrator. The charge runs approximately 1.5 to 1.75 cars of concentrate, 0.75 cars of limestone, 0.75 cars of iron ore, and 0.5 cars of quartz ore. No accurate measurement is made of the cars, as the laborer is instructed to use his judgment of what constitutes 0.75 of a car.

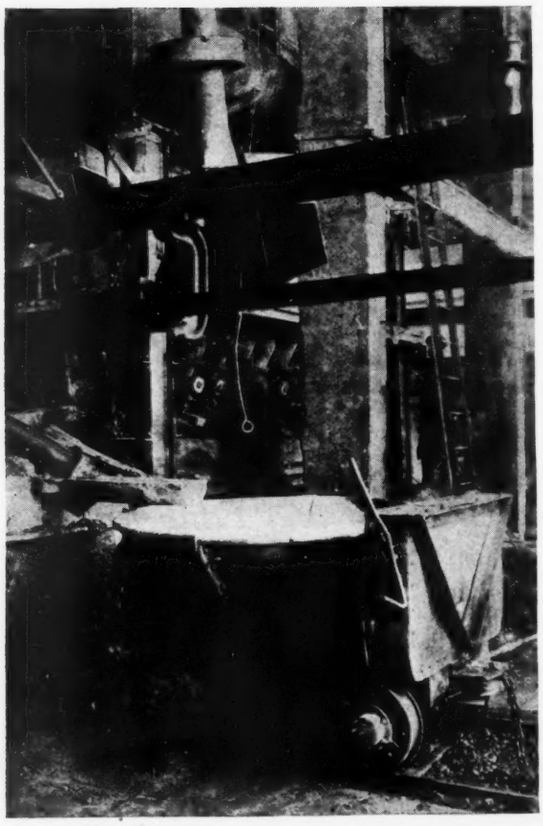
The crushed material runs on a belt conveyor from the disintegrator to the hopper directly over the roasting machines. From the hopper it drops down onto a mixing table, where water is added as found necessary by the hand-squeezing test, and from here fed to the pallets of the roasting machine, being spread out more or less uniformly by a mechanical arm. Roasting is done in two stages, and the partly finished material which comes off the first machine is carried up in a skip to the feed hopper on the second roasting machine, where the roasting is done and the material more or less agglomerated. A third roaster operates alongside of the No. 2 machine and handles all the fines from No. 2 machine mixed with some fresh material from No. 1 machine. Two roasters are kept in reserve. The final product of the No. 2 and No. 3 machines passes into a small bunker, from which it is drawn at will into the small overhead monorail cars and carried to the charging floor of the blast furnaces. The roasting machines are Dwight-Lloyds of standard pattern, size 42x264 in. and 60x460 in.

The ignition chamber on each machine burns coke, and for a period gave trouble, as the brick lining melted, but this was eliminated by running a water-cooling pipe around the hot zone. An open tube manometer on the exhaust chambers gave control readings of the suction. Due to unskilled and undisciplined workers, these machines often become clogged with seeping fines, badly cleaned pallets, and poorly lubricated parts, but these defects are being slowly corrected.

It was found that by adding 10 to 15 per cent of water and not over 5 per cent of coke fines, even the high zincy concentrates made a fairly well-sintered product and reduced the large amount of recirculating fines from the No. 2 to the No. 3 machine. During the summer months, when concentrate from the Zyrianovsk mill is added to the charge, little change is made, except that more copper and silver are obtained in the products. However, the metal losses in the roasters have been estimated to run as high as 15 per cent.

The process continues as the sinter or agglomerate product is taken from the bins at the end of machines Nos. 2 and 3, and run down in cars to the blast-furnace charging level. Here the sinter is mixed

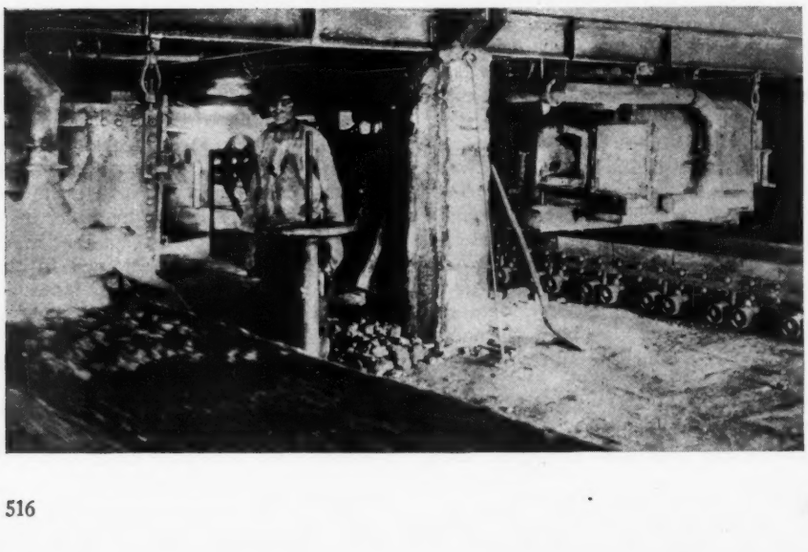




A LIME KILN about 18 km. from Ridder, at the foot of a limestone quarry, which supplies burnt and unburnt stone as flux for the smelter. Firewood is brought here at great expense, but nevertheless it was the cheapest material available for covering this kiln

BLAST FURNACE in the Ridder smelter. The slag pot is one of a new design, and is being filled by slag, overflowing from the settler. The boxlike arrangement attached to the vertical pipe passing through the suspended tin halo above the slag pot is a ventilating device, whose efficiency approaches zero

THE KAZACK sintering attendant below sees to the Dwight-Lloyd roasters. Most of the labor employed in the smelter is Kazack. This race has a custom, among the men, of wearing heavy felt hats trimmed with fur over skull caps. This native clings to the custom in spite of the heat from the roasters



by hand on a sheet-iron floor, with coke and more fluxes such as limestone, scrap iron, litharge from the cupels and skimmings from the refining and softening furnaces, and scrap from the blast furnaces (of which there is always an unusually large amount). Then it is necessary to shovel the charge onto the inclined plates and push it into the furnace.

There are three blast furnaces, two rectangular ones known as No. 1 and No. 3 and a small, round blast furnace, No. 2. The larger ones have sixteen tuyeres each and the smaller one has eight. One large furnace operates continuously; the other large one is blown in when the first needs repairs or is frozen. The small, round furnace operates on hard antimonial lead or when it becomes necessary to complete the month's assignment of production, and some difficulties exist with the large furnaces. The area at the tuyeres is 3.6 square meters for the larger and 1.8 square meters for the smaller. The water-cooled caisson is of the following dimensions: 3,350 mm. over-all length, 2,000 mm. over-all height, 1,668 mm. width at top, and 1,266 mm. width at bottom of section. The tuyeres are 1,524 mm. from top and 1,066 mm. from the bottom of the metal casing. In the larger furnaces there are eight plates bearing the tuyeres, four on each side, two tuyeres per plate, which is 825 mm. in length.

Before the slag spout is a rectangular settler with three spouts, one for slag, one for matte, and one for molten metal. Each furnace was provided with a syphon, but invariably it freezes up after a few short hours of working. Slag runs off the top of the settler into slag pots of new design. Spouts are opened and closed by hand.

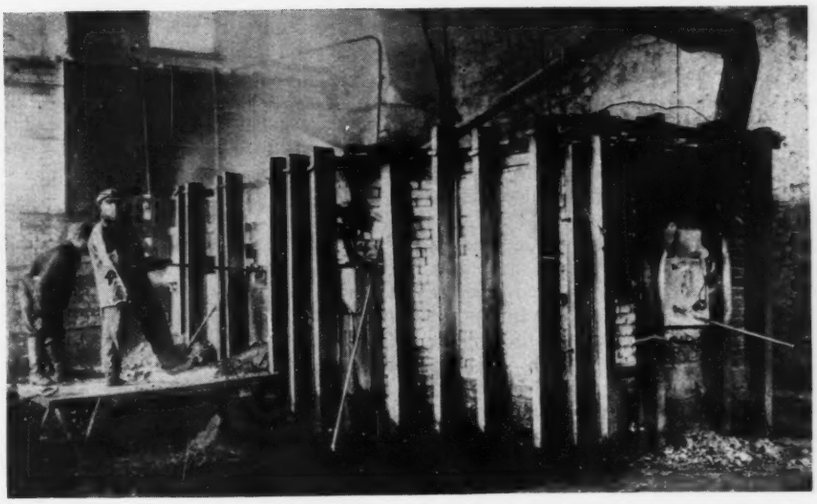
As indicated by the wide latitude in these analyses, there is similarly a wide range in practice. It has been determined, however, that a slag with about 28 per cent Fe and 24 per cent SiO_2 and 12 per cent CaO will run smoothly. To a large extent the metal losses in slag and matte may be due to awkward manipulation and inexperienced labor. These metal losses have been estimated as 6 per cent in the blast-furnace gases, 5 per cent in the mattes, and another 5 per cent in the slags, and probably these are low estimates.

Slag is run off into slag pots and hauled to the slag dump. Matte is run off by the same means to a dumping spot near the tracks and from there, at intervals, hand-loaded onto flat cars and shipped to the Karabash and Krasnaioural copper converter plant. The lead is tapped from the settler into small kettles, and from these is hand-poured into loosely lying ingots (28 to 35 kg. each), and then hand-loaded onto small cars and carried by the overhead monorail to the refinery.

In the Ridder lead refinery, at present

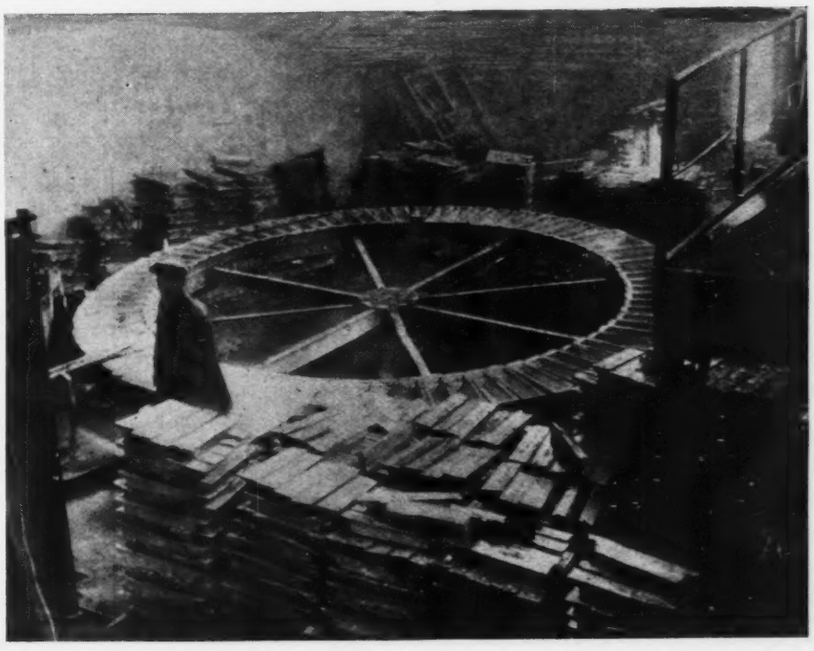
there are two reverberatory softening or refining furnaces, three Parkes kettles—two for regular handling of desilverizing to make soft lead and one for desilverizing antimonial lead; also there are five Faber du Faur retort furnaces for handling the zincy drosses and two cupels for making doré metal.

The reverberatory furnaces are 4,160 mm. in over-all length (inside dimensions only given here), 1,960 mm. width, 1,140 mm. over-all height, and 542 mm. from floor of furnace to metal level. The kettles are ordinary cast iron, 1,257 mm. inside radius, and hold about 40 tons of molten metal. The Faber du Faur retort furnaces are coke-burning, charging from the top through an opening in a loosely hanging flue. Soviet-made graphite retorts copied from the Belgian 500-kg. size are now used. The cupels are magnesite-brick lined, with stationary roof and removable hearth of the forward lowering type, holding a maximum of 1,000 kg. of metal.



SOFTENING FURNACE NO. 1, from which the attendant and his helper remove the black copper skimming. The smaller pipe leading from the large one is used for forced draft to the firebox

A PARKES' KETTLE in the refinery nearly full of molten lead. Suspended above the kettle is a Howard mixer which is lowered into position for stirring the molten metal



THE CASTING WHEEL below contains 85 molds for making lead bars. The molten metal pours from the spout of the second refining furnace into the molds as the attendant turns the wheel. Ingot bars are loaded into freight cars through the open passage at the upper right

Cold, hard lead ingots are charged into the "first softening" furnace by hand, amounting from 40 to 45 tons per operation. Coal, when available, or wood is burned with forced draft in all fireboxes. Skimmings are made through the charging windows, and consist of a low-temperature-forming black, coppery skimming which should remove most of the copper, and takes appreciable gold, silver, antimony, and lead with it. After skimming, the metal is allowed to flow by gravity along an old channel-iron sluiceway to the first Parkes' kettle. In the kettle cold scrap refined metal or liquated lead are added to cool the bath, and coal fines are used generously to keep the skimmings less wet with lead. Then repeated skimmings are taken off the kettle, using native sulphur or even the concentrates from the "Gold Section" of the mill (bearing about 20 per cent sulphur) to remove the last copper. Zinc is used to remove the precious metals. A second zinc addition is made, and then the molten metal is allowed to run out through a cock at the bottom along a similar channel trough by gravity to the second softening and refining

reverberatory furnace. Here, with the aid of air and water, the zinc and antimony are removed by skimming and partially burning, and finally the refined metal is cast on a hand-turned wheel into ingot bars averaging 27.5 kg. each. These are loaded by hand into 12-ton box cars, which are sealed before shipping.

The dross taken off the kettle bearing the precious metals is treated first in a small liquating kettle to remove some of the lead and to break up the larger chunks, and is then passed through a chute to the cupellation section, where it is further treated. Dross, which had been mixed with a small amount of coal fines either during its liquation or on the floor before the retort, is charged into a heated retort and sealed with a condenser to run for about sixteen hours. At irregular intervals a small hole is tapped in the condenser and zinc metal drips out into a small ingot mold set to catch it. After the zinc is considered removed, the condenser is taken away from the front of the retort and the furnace tipped forward to pour out the rich lead bullion and to scrape out the white powder and any other material, which is called "zinc dust." The final operation came when the cold ingots of lead bullion were charged (from the rear), ingot by ingot, and slowly, to allow some of the lead to oxidize off and so keep the hearth from overflowing, when, after seven to nine days of such slow charging and careful draining of litharge, the cupel was poured and the doré metal cast into small ingots. Each ingot would then be placed separately in a burlap covered wooden box. Each box is numbered and labeled, and then shipped under escort to the electrolytic refinery of the mint in Moscow or in Leningrad.

Table XV gives a detailed picture of the functioning of the refinery in December, 1934. Certain changes have been made in an effort to improve the product and reduce the losses. For example, up to December, 1934, the refined lead was 75 per cent of low grade, Soviet Standard S 3 and S 4, and not over 25 per cent of high quality metal. It seems that too much antimony and precious metals were left in the lead. Under our supervision this was corrected, so that the high-quality lead could be produced as desired. The problem of removing the copper from the lead, especially the last traces from solution, was fixed and the process more or less standardized. Many of the losses were due to unskilled and undisciplined workers, as is the case elsewhere. One large loss of precious metals had been in the "zinc dust," so-called, which was produced in excessive quantities carrying precious metals 40 to 50 kg. per ton. This problem was also definitely solved under our guidance, and a general technical control set up throughout the smelter. Interesting data on detail matters have been collected, but are not included here, as they are considered outside the scope of this general article.

At the Ridder smelter, a small Cottrell apparatus began working early in 1933. At present only the gases from the blast furnace are sent through the Cottrell, but, this not being sufficient, a baghouse, patterned very closely to that of Port Pirie, Australia, is now under construction. From some measurements, the burden sent to the Cottrell is about 27 cu.cm. per second of gas, whereas its capacity is more nearly 9 cu.cm. The gases carry about 1.275 grams dust per cubic meter of gas on entering, with an average moisture of 12.4 per cent and speed of about 6.7 meters per second.

At intervals zinc concentrate is roasted in the acid house. The acid is made by an adaptation of the Glover process, and is used in the electrolytic department.

The dust collected in the flues, which are opened and cleaned with varying efficiency at irregular intervals, together with the dust collected in the Cottrell, is sent to the electrolytic department to be treated for the extraction of cadmium by the electrolytic process. This is the

Table XIV—Characteristic Analyses of Roaster Charges

Material	Grams per Ton Au	Grams per Ton Ag	Per Cent Cu	Pb	Zn	Fe	SiO_2	CaO	S	Sb	Al_2O_3	H_2O
Concentrate (Ridder)	96	325	3.7	38.8	12	.....	.....	....	.....	....	....	10.0
Concentrate (Zyrianovsk)	15	1,500	11.4	43	12	.....	.....	....	.....	....	....	6.7
Limestone	.....	.....	.....	.....	....	2 to 3	4 to 6	50.0	.....	....	....	....
Iron ore	.....	.....	.....	.....	....	61 to 63	7	0.8	.....	....	5	....
Quartz ore (Ridder)	15 to 30	70 to 500	0.8	3 to 7	1.3	5 to 8	70	....	1	....	....	....
Mixed charge	42	677	3 to 5	21 to 31	....	.....	.....	....	10 to 18	....	....	....
Final sinter	38	675	4.5	21 to 25	10	16	19	9.4	3 to 4	....	....	....

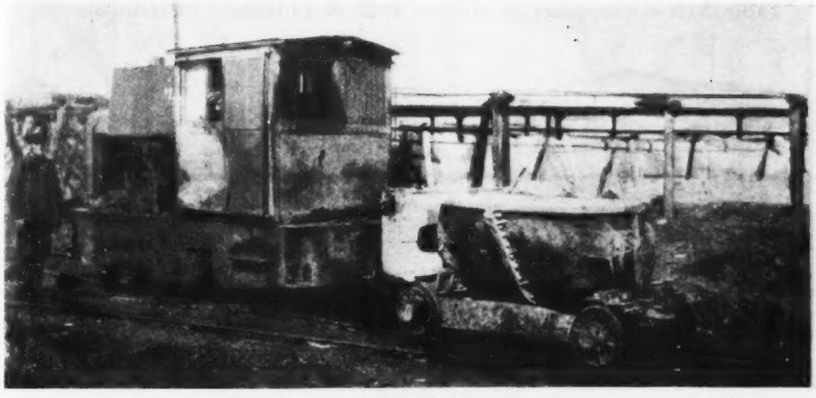
Table XV—Characteristic Analyses of Blast-Furnace Charges

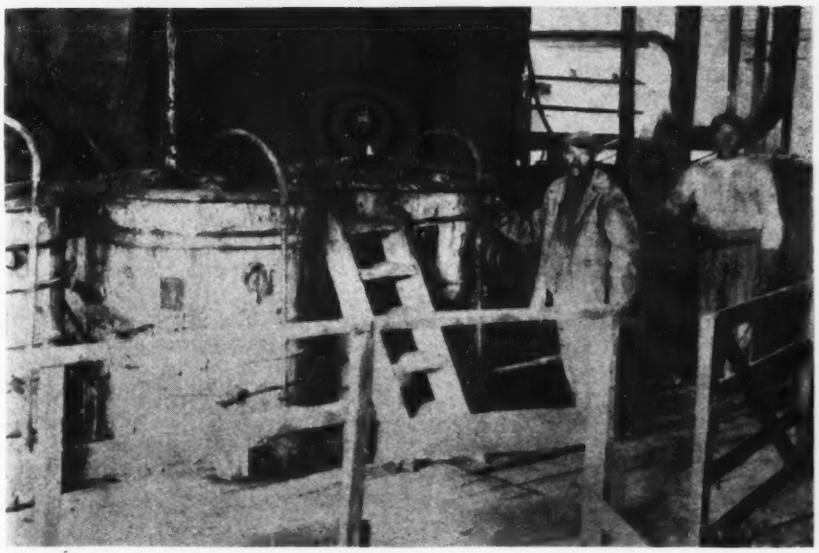
Material	Grams per Ton Au	Grams per Ton Ag	Per Cent CO	Pb	Zn	Fe	SiO_2	CaO	S	Sb	Al_2O_3
Large b.f. slag	0.8	34	0.1 to 1.5	1 to 2	12	28	22 to 27	12 to 15	..	.....	3.5 to 6
Small b.f. slag	0.8	34	0.1 to 1.5	1 to 4	12	29	22 to 25	9 to 14	..	.....	4 to 6
Large b.f. matte	10.0	500 to 800	30 to 40	15 to 20	7	12 to 20	.....	.....	18	3	.....
Hard-lead ingots (Large b.f.)	300 to 400	2,500 to 3,500	5 to 15	.....	....	.....	.....	.....	..	0.8	.....
Antimonial-lead ingots (Small b. f.)	75	300	1	.....	....	.....	.....	.....	..	2 to 9	.....

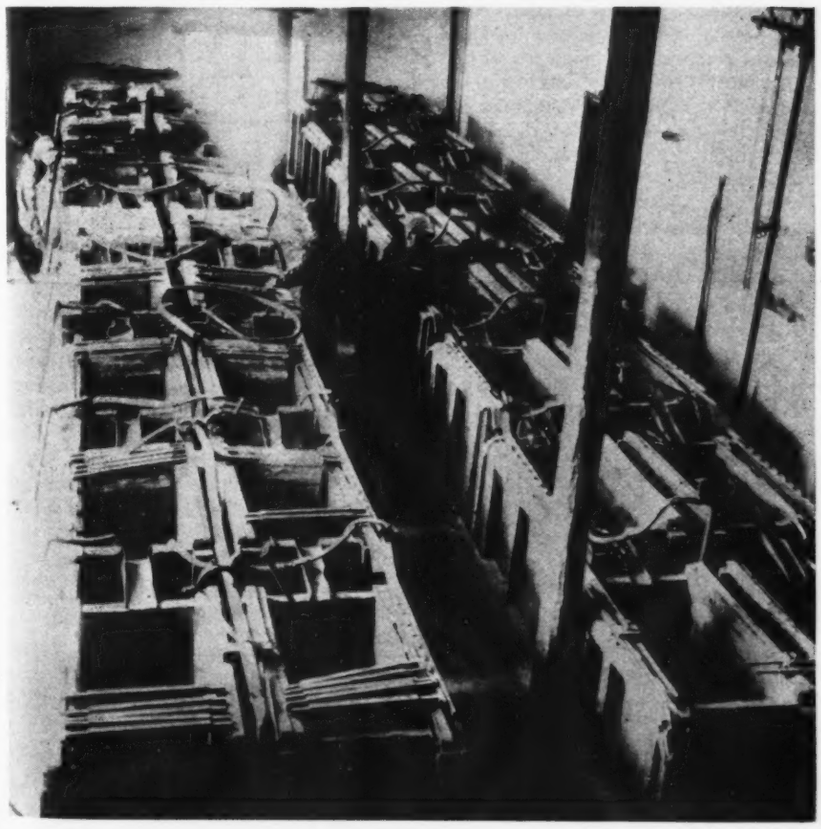
Blast furnace is abbreviated "b.f."

Table XVI—Metal Balance of the Ridder Lead Refinery

FURNACE NO. 1 Material	Kilograms	Assay Grams per Ton Au	Assay Grams per Ton Ag	Per Cent Cu	Per Cent Pb	Per Cent Sb	Kilograms Au	Kilograms Ag	Kilograms Co	Kilograms Pb	Kilograms Sb
Hard-lead ingots	38,250	275	2,450	2.18	94.0	0.700	10.5187	93.7393	833.85	35,970.00	268.130
Skimmings from first kettle	425	1,198	2,811	9.10	86.95	1.910	0.5092	1.1947	38.675	369.54	8.117
	4,722	3,129	11,031	3.28	90.69	0.584	14.7752	52.0884	154.880	4,282.40	27.577
Products	3,607	108	2,532	0.14	96.53	0.511	0.3896	9.1329	5.050	3,481.84	18.343
Skimmings	2,676	2,495	3,086	14.79	70.1	2.540	6.6767	8.2581	395.78	1,875.61	67.970
	2,773	2,165	2,799	19.61	66.37	4.470	6.0027	7.7616	543.785	1,840.44	123.953
Metal	41,555	390	3,313	1.53	98.1	0.663	16.2065	137.6717	635.790	40,765.00	271.354
PARKES KETTLES											
Charged											
Liquated scrap	240	.842	13,465	.032	80.60	0.617	0.2022	3.2317	0.768	193.44	1.481
Sulphur	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Zinc	750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Dross scrap	2,800	4.000	617	tr.	96.03	0.445	0.0112	1.7276	tr.	2,688.24	12.460
Liquated lead	4,698	141.000	4,542	0.04	99.40	0.562	0.6624	21.3383	1.879	4,669.80	26.403
Refined scrap	300	1.000	88	0.0029	99.79	0.089	0.0003	0.0264	0.0087	299.37	0.267
Produced											
First skimming	3,105	1,125.0	3,940	8.380	89.84	1.780	3.4941	12.2151	260.28	2,789.53	55.269
Second skimming	1,389	446.0	2,776	2.830	96.63	0.534	0.6195	3.8559	39.309	1,342.20	7.417
Rich zinc dross	2,790	3,235.0	34,885	0.940	89.22	0.497	9.0165	97.2283	26.226	2,489.20	13.866
	415	677.0	24,511	0.280	84.53	0.653	0.2810	10.1721	1.162	350.799	2.7099
Drossy zinc skimming	781	8.0	1,961	0.006	97.44	0.549	0.0062	1.5003	0.046	761.006	4.2877
	4,300	10.7	1,867	0.012	93.98	0.481	0.0460	8.0581	0.516	4,041,100	20.683
Desilverized lead	33,480	0.5	5	0.003	99.40	0.532	0.0167	0.1674	1.004	33,279.10	178.110
FURNACE NO. 2											
Produced											
Zinc skimming	1,307	2.72	17.19	0.0167	68.58	2.027	0.0036	0.0225	0.2183	896.34	26.493
Antimonial skimming	469	2.18	16.78	0.0230	59.49	9.540	0.0010	0.0079	0.1079	279.01	44.738
Refined scrap	2,000	0.10	6.00	0.0029	98.26	0.080	0.0002	0.0120	0.0580	1,965.20	1.602
Refined lead	30,000	0.20	5.60	0.0005	99.98	0.0228	0.0060	0.1680	0.150	29,994.00	6.890







THE GASOLINE LOCOMOTIVE above hauls the slag pots to the dump. These cast-iron oval pots have replaced the buckets which ran to the slag dump on an overhead monorail seen in the background

SMALL PACHUCA tanks are used for the preparation of cadmium-bearing solutions. They have also been used in making copper sulphate from matte

ELECTROLYTIC DEPARTMENT at Ridder, where Russian women as well as men are employed as metallurgists. Busbars carrying the aluminum cathodes are seen in the lower left-hand cells

first cadmium producer in the Soviet Union, and the purity of the product has been 99.76 to 99.90 per cent. Tests have been made recently to improve the quality, and by making a second deposition or re-treatment of the first cadmium precipitated on the aluminum cathodes it has been possible to make cadmium with 99.98 per cent purity. All the cadmium made at Ridder is consigned for military purposes.

To recover the antimony in the ore, part of which appears in the hard lead ingots, the Harris process is planned to be used for refining the metal, beginning in 1937. This is to be installed by revamping the present refinery.

One unusual feature about the Ridder smelter is the large number of people who contract lead poisoning. Daily accidents are also numerous. In 1934 11,500 shifts were lost due to all illnesses. In the first quarter of 1935 there were 269 persons on the sick list and 1,209 shifts lost, 86 persons on the lead poisoning list, and an additional 1,180 shifts lost. No safety work is carried on at the smelter, for one thing, and the ventilation system, which had been planned for some time previously and finally put in at the middle of 1935, does little or no ventilating.

Coal and coke for the Altai region are now brought over the Ridder-Rubtzovka railroad from the Karaganda and Kuzbas coal fields. Previously, when shipping by boat, the coal and coke would lie for long periods along the banks of the Irtysh River, where it would be mixed with fine sand. At one time, at Ridder, at Zyrianovsk, and at Belousovsk, some 5,000 tons or more of coal and coke fines were mixed with sand from the river. The problem of cleaning was worked out under our direction by washing the fines to remove the sand from the fuel fines and then briquetting, using as binder material sawdust and limestone crushed in proportions so that the briquet might be used in the blast furnace charge.

The electrical power supply in the Altai may be briefly summarized as follows: Ridder has a coal power plant of

Table XVII — Arsenic, Antimony, and Cadmium Assays

Material	Per Cent Arsenic	Antimony	Cadmium
Overflow from bowl classifier	.....	0.0331	0.0350
Lead concentrate	.....	0.1482	0.0878
Zinc concentrate	.....	0.0653	0.2075
Tailings from mill	.....	0.0228	0.0114
Dust from Cottrell	0.146	0.3890	1.8500
(Three different batches)	0.139	0.3390	1.6500
	0.270	0.5900	0.7330

Table XVIII—Summary of Smelter Practice, 1935

Metal Production

Refined lead, metric tons	10,000
Copper-lead matte, metric tons	4,100
Antimonial lead, metric tons	450
Doré metal, kg.	22,500
Gold, kg.	2,250
Silver, kg.	19,500

Flux Consumption

Ridder concentrate used, metric tons wet	20,350
Zyrianovsk concentrate, metric tons wet	9,600
Fluxes: Quartz ore, metric tons wet	17,242
Iron ore, metric tons	15,700
Limestone, metric tons	17,000
Sinter made, metric tons	80,000
Coke per ton b.f. charge, kg.	135
Hard lead, metric tons	14,000
Sulphur per ton refined Pb., kg.	15
Zinc per ton refined Pb., kg.	2.5

Fuel: Coke 931 kg./ton refined Pb.
Wood 1.5 cu. m./ton refined Pb.
Coal 20 kg./ton refined Pb.
Electrical energy 0.415 kw.h./m. refined Pb.

Labor Data (Monthly Average)

Labor, averages 520 to 540 (entire smelter)
Roasting dept., 18 to 24 tons sinter per worker
Blast-furnace dept., 5 to 10 tons hard lead per worker
Refinery dept., 6.5 to 10.5 tons refined lead per worker

Table XIX — Summary of Ridder 1932-34 (Inclusive) Production

Metric Tons

Material	1932	1933	1934	1st Quarter 1935
Ore mined	168,485	160,728	206,217	68,941
Pb concentrate	12,584	9,534	16,955	5,319
Zn concentrate	15,614	15,487	26,327	8,086
Refined Pb	3,832	2,837	7,012	1,721
Doré metal, kg.	9,117	6,839	17,017	3,716

Table XX — Per Cent Metal Recovery

1934					(a) 1933	(a) 1936–1942
Pb in Pb concentrate	71	Pb as refined Pb	75	Total Pb	0.51	0.89
Zn in Zn concentrate	65	Cu as matte	79	Total Cu	0.40	0.82
Cu in Pb concentrate	49	Au as doré metal	80	Total Zn	0.55	0.83
Au in both concentrate	81	Ag as doré metal	78			
Ag in both concentrate	87					

(a) The Stakhanov method of work may achieve greater unit production in all branches of industry, and the higher figures for recovery (above 80 per cent for each metal) may possibly be surpassed.

Table XXI — Mill Capacity for the Altai

Metric Tons Daily

	1934 (a)	1937 (b)	1942 (b)
Ridder	1,000	2,000	3,500
Zyrianovsk	250	500	,800
Belousovsk	.....	1,000	2,000
Berezovsk	.....	.....	250

(a) Actual. (b) Planned.

Table XXII—Metal Smelting Capacity in Altai

Metric Tons Annually

	1934	1937	1942
Ridder Pb	12,000	24,000	25,000
Glubokaya Pb	.....	10,000	25,000
Copper converter	.....	10,000	18,000
Zinc (electrolytic)	.....	.....	50,000

Planned projects include a copper converter and a zinc electrolytic plant at or near Glubokaya.

5,500-kw. capacity, and three hydro-electric stations, of which the Upper Kharizovka plant produces 3,000 kw., the lower Kharizovka 800 kw., and Bistrushinsk 600 kw. The total energy output of these units is 1,200 kw. in winter and 3,400 kw. in summer. By the end of 1936 a part of the big Ulba River hydro-electric plant will be completed to supply 3,000 to 4,000 kw. By the end of 1937 Ridder will have available 25,000 kw. in summer and 18,100 kw. in winter from these new plants. The Belousovsk group is served by the coal power plant at Glubokaya, with 5,000 kw. capacity. There is in project a hydro-electric plant near Ust-Kamenogorsk using the Irtysh River to provide power for projected copper and zinc plants. Zyrianovsk has a coal power plant, of 1,450 kw. capacity, and the Turgusun hydro-electric plant with 1,100 kw.

The weakest point for a more rapid development of the Altai mining region is the lack of adequate transportation. The cost of transporting one ton of goods via truck and camel, from the Semipalatinsk railroad station to Ridder, a distance of 305 km., is 50 to 60 rubles in summer. In winter this figure is prohibitively high due to severe weather, bad roads, and general lack of organization to cope with the difficult conditions. The completion of the Rubtzovka-Ridder branch of the Siberian-Turkestan railroad is now ironing out some transportation difficulties, but all forms of transportation are still carried on in the region. Development of the Zyrianovsk and Belousovsk mines will depend on a fleet of trucks and improved roads, as well as the usual summer river transportation.

The Altai polymetal deposits have an ambitious future, as can be seen from the tables included here. Their development is entrusted to young and vigorous men, most of whom are recent graduates of the technical universities of the Soviet Union and who usually have more enthusiasm than experience. Their aim is to reach American efficiency, and with time they will learn the ways of modern industry and eliminate mistakes resulting from overconfidence and lack of experience. Much credit is due to A. S. Shakhmouradov, Chief of the Non-Ferrous Trust of the U.S.S.R., for raising the production and efficiency of the Altai polymetal industry. He urges his engineers to act on their own initiative and declares that the welfare of each industrial unit depends upon the ability of the men who compose it.

The great labor turnover which plagued the Soviet industrial organizations formerly is much reduced now. Better living conditions and means of education and recreation are provided and the men are urged to settle down near the mines.

By the end of 1936 two sore spots in the Altai program, power and transport, will be appreciably eased, and because of this, further development of the region will be greatly facilitated.

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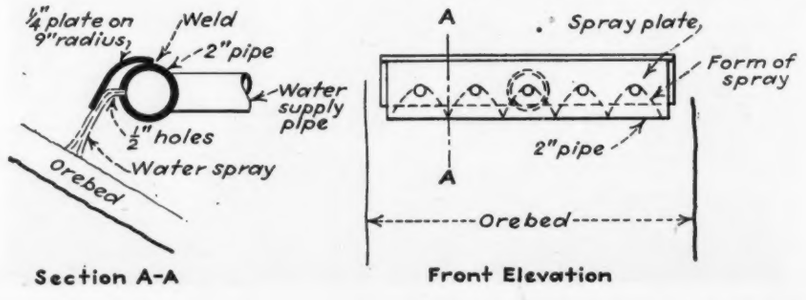
Spray Nozzle Improved

A NON-CLOGGING spray line was developed at the Canisteo washing plant at Coleraine, Minn. It is made of standard pipe and plate welded, as shown in the accompanying sketch. With straight ½-in. holes for nozzles, no sediment in the water will plug the pipe, and with the nozzle water striking the curved plate and spreading V-shaped a perfect sheet of water is deflected for wet screening. This same scheme is used on smaller pipes where less water is needed. The illustrated spray is one of three on a 4x10 Allis-Chalmers vibrating screen operating under a load of 250 tons an hour.



Natural Ventilation In Mines

Illustrated by Clever Model

Means of controlling temperature of workings a feature of apparatus

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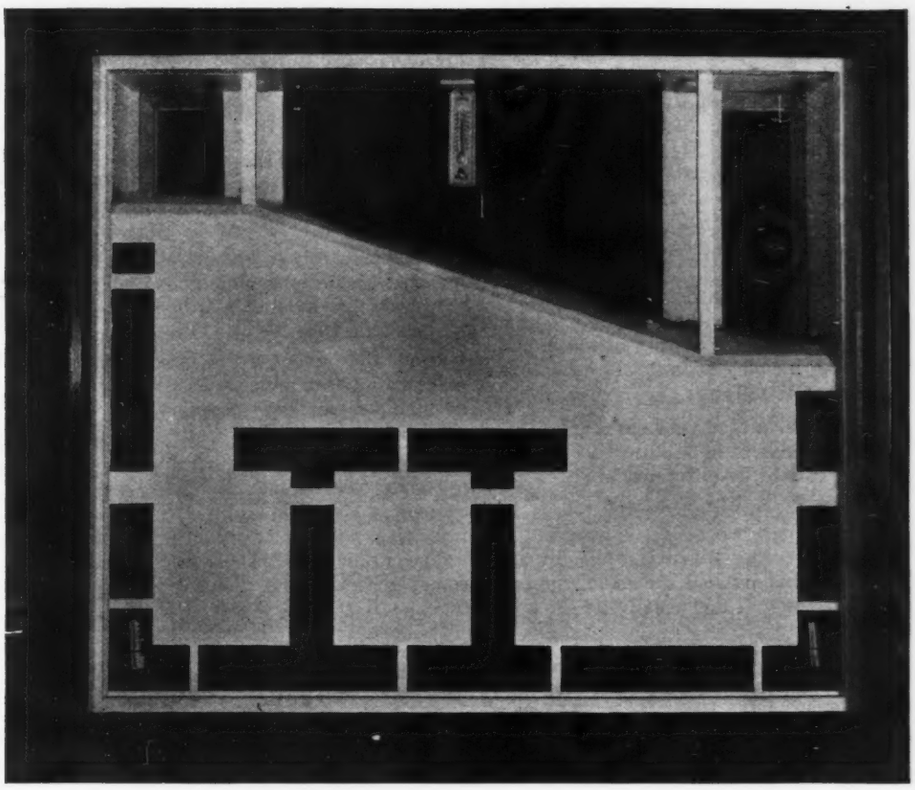


A MINE MODEL that serves to illustrate natural ventilation. Representing a cross-sectional view, the passageways have been constructed as one continuous water jacket, permitting any temperature to be obtained

APPARATUS constructed for the purpose of aiding the explanation of natural air currents existing in mines has recently been completed under my direction at the Minnesota School of Mines. Built in the form of a cross-sectional view of an underground mine, it serves to make visible the paths taken by air currents under variable temperature conditions. The phenomena of natural ventilation in mines are frequently baffling, especially to those not yet initiated to the variations possible. With this fact in mind, steps were taken to simulate in a model the actual controlling relationships of ventilation factors existing in mines. A generalized cross-section of mine workings has been constructed. A wooden box 42x36x14 in. in dimensions completely incloses the entire apparatus. This box is placed in one of our regular exhibition cases, as shown in the photograph. Two shafts of different collar elevation are provided, which are connected by means of a straight and horizontal passageway. To minimize the effects of wall friction, the raises start at points which are each equally distant from the nearer shaft collar. The two raises are further connected by a horizontal passageway above.

All passageways are 1x1 in. in cross-section. In a later model, to be constructed, this series of passages will be added to and doors, blowers, and the like will be included. A third shaft will also be added. Thus, selected standard underground types of openings are incorporated in the structure.

Complete temperature control of the underground workings is obtained by constructing the passageways as one continuous water jacket. See Fig. 1. Hot- and cold-water connections provide a means of obtaining any desired temperature control within the mine. The water jacket forms three sides of the passageways and the plate glass in front forms the fourth side. The cover board is beveled to 45 deg. to obtain the best possible view of the interior. All parts are securely and snugly fitted together to prevent air leakage. The interior of the mine is painted black, the bevels are gray, and the exterior is white. When smoke is introduced into the workings it is clearly visible. Thermometers are placed at the bottom of each shaft to indicate the interior temperature.

Smoke enters, one puff at a time, at the two opposite ends of the upper level. It enters in two fine streams which strike each other at the middle of the level. No noticeable artificial current of air is set up by the entering smoke blast. All effects produced are entirely dependent on the temperature conditions encountered. The smoke is picked up by the existing current and carried out of the mine, its direction of travel clearly seen by the observer.

The "surface" is made of $\frac{3}{4}$-in. board, shaped and placed to accommodate the difference of elevation between the two shafts. The outside of the mine is also equipped with water tanks to be used as temperature regulators. One of these is buried beneath the ground and the other is set vertically at the back. The glass-covered front and the closed ends of the model completely confine the smoke escaping from within the mine. Small ventilators at the top of the inclosing box serve as a means of slowly allowing the smoke to escape. Mirrors placed against the back of the model, behind the shaft collars, aid in increasing the visibility of the smoke. A thermometer is

placed against the back water jacket in view of the observer. This indicates the exterior temperature.

Tobacco smoke is used in making the air currents visible. Other smokes were found to be too corrosive and clouded the glass too rapidly. Several methods of introducing the smoke are available; the best means so far attempted, however, is the apparatus shown in Fig. 2. Its method of operation is quite obvious. One half of a standard-size tailor-made cigarette forms the usual "charge" for a demonstration. Fig. 3 shows a rear elevation of the apparatus in which smoke and water controls and connections are outlined. The heavy outline represents the water-jacketed passageways.

Before giving a detailed explanation of the operating features of this model it is well to set down certain of the fundamental principles of natural ventilation. These are as follows:

1. Natural air currents in a mine are chiefly dependent upon differences of air density caused by differences in air temperature.

2. In mines where no difference in temperature exists between the air inside and that outside the mine, natural air currents will not usually be set up.

3. In mines where the shafts are all of nearly the same collar elevation, natural air currents are not readily set up, and may never be established unless influenced by other agencies, such as steam pipes, cold dripping waters, and like factors.

4. Natural air flow is quite readily set up in mines where the shaft collars have an appreciable difference of elevation, if sufficient temperature difference exists between the outside and the inside of the mine.

The causes of the temperature differences referred to are generally well understood and will not be discussed here.

A demonstration of the points enumerated in the foregoing is available in the apparatus herein described.

Case 1—Temperatures within and without the mine are the same. Smoke is blown into the upper level. The smoke accumulates in the passageways, but none passes out either shaft.

Case 2—Temperature within is made to exceed that without by about 5 deg. F. Smoke is blown in as in Case 1. The raise nearer the shaft of higher elevation becomes downcast. The other raise becomes upcast. Smoke flows rapidly from the mouth of the shaft of higher elevation. Any smoke from previous demonstrations which may have accumulated around the collar of the shaft of lower elevation is carried downward, around, and up the other shaft. In the early part of this demonstration, the air in the upper level is cooler than that in the lower level. Thus we find the colder, heavier air settling to the bottom of the raise nearer the upcast shaft, and for a time the "preferred" circulation is down the short shaft, up the first raise, down the next raise, and then out the long shaft. After uniform heating obtains, this condition does not exist.

Case 3—Temperature without is made to exceed that within by about 5 deg. F. In this case the smoke passes up the shaft of lower collar elevation. The raise nearest the shaft becomes downcast; the other raise shows upward currents for a short time. Soon, however, turbulence is visible in both raises. The smoke against the glass, and therefore nearest the observer, is seen to be passing upward while that next to the cooler walls is seen to be passing downward. This effect may be compared to that caused by water pipes and similar equipment in mines. In later models glass water jackets may be used to eliminate this effect in one part of the apparatus. In Case 3 the long shaft is downcast.

Thus a variety of phenomena are visibly displayed to the student and a good foundation is laid for a clear understanding of the problems of natural mine ventilation. The seemingly baffling phenomena of reversing currents in mines between day and night and between summer and winter or vice versa are thus placed among those of easier conception. With certain additions and improvements as herein suggested, other equally important fundamental principles may also be demonstrated.

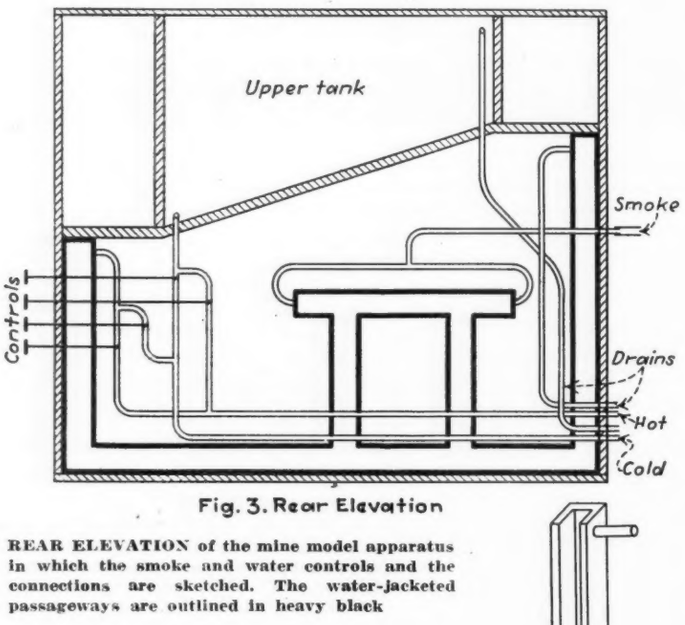


Fig. 3. Rear Elevation

REAR ELEVATION of the mine model apparatus in which the smoke and water controls and the connections are sketched. The water-jacketed passageways are outlined in heavy black

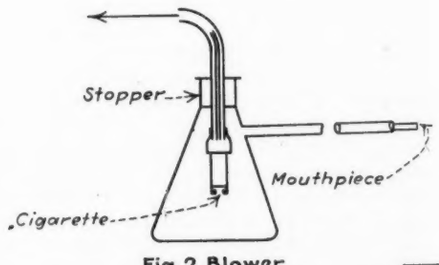


Fig. 2. Blower

THE WATER JACKET, here sketched, is equipped with hot- and cold-water connections, providing the means of temperature control used to vary the conditions. Above, at right, Fig. 2. . . . BLOWER devised for introducing tobacco smoke into the "workings" to make the air currents visible

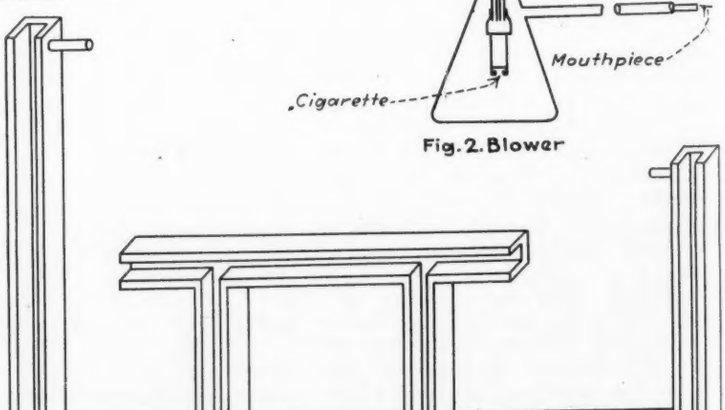


Fig. 1. Water Jacket

NEWS
OF THE INDUSTRY

Jubilee of the Rand—
The Johannesburg Empire Exhibition

INTERESTING HIGH LIGHTS of South Africa's "Golden" Anniversary

CELEBRATING the most memorable event in the history of South Africa—the discovery of the Witwatersrand gold fields fifty years ago—the Johannesburg Empire Exhibition was opened on Sept. 15. Exhibits from all parts of the British Empire, representing a value of about $10,000,000, make this exhibition the largest held in the Southern Hemisphere.

Most striking among numerous other displays is the exhibit shown by the Transvaal Chamber of Mines. Dominating the Chamber of Mines Pavilion stands the "Golden Pillar." Rising to a height of 70 ft., the golden column represents three years' output of the Rand and a sum equal to approximately $1,000,000,000.

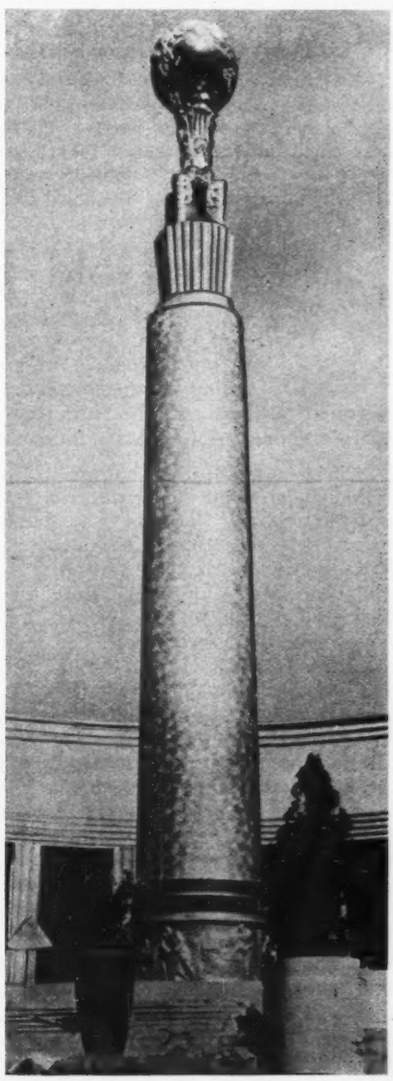
A complete miniature "mine" provides visitors with complete details of underground workings on the Rand. Approached by two stairways, the artificial stope is nearly 100 ft. long. A highly realistic "section" is shown with rails carrying cocopans and a full-sized modern underground locomotive (6-ton). Various types of supports, packing, timbering, "pancakes," etc., are seen in position and the "rock" is also there, looking like the real thing.

More than 200 ft. in length, an outstandingly interesting and picturesque historical frieze runs around the main hall in the Pavilion. It shows the entire "Calvacade" of the Rand's history, with hundreds of figures from the time of the proclamation of the gold fields in 1886 to the present day. Equally remarkable in another way is the world-famous collection of gold ores from all parts of the world, belonging to H. S. Gordon, of Cape Town.

"Moving Flowsheet." This expression has been coined to describe a most alluring set of working models prepared by the leading geologists of the Rand. Here is seen in miniature the entire process of gold recovery from the ore, with tiny cyanide tanks and other plants operating behind glass partitions, with an exhibit of gold bars marking the ultimate result.

Other features are the displays by the Union Geological Survey, the Government Mining Engineer, and diagrams and pictures illustrating the development of the Government's stake in the gold industry.

Protected by invisible rays, an exceptionally elaborate strong room and a police station is perhaps most spectacular feature of the whole Empire Exhibition—the diamond display organized by De Beers Consolidated Mines. Lined with black glass and lit from hidden points, this section of the Pavilion is harboring diamonds worth over a million dollars.



THE GOLDEN PILLAR at the Jubilee which represents gold output for three years from the Rand, a sum equal to about $1,000,000,000

Admittance to this hall is only gained by visitors singly, and the rule is "one-way traffic." The sight-seer finds himself in a windowless room, artificially ventilated. Along the table at one end is an artistically arranged selection of magnificent diamonds. Rotating on a kind of miniature tower, catching the lights as they flash on the facets, is a gorgeous selection of cut stones. Specimens as large as 200 carats have been taken from the De Beers vaults and there are also numerous colored and freak gems which ordinarily are not seen by the public.

An accurate scale model of the famous "Big Hole" at Kimberley is occupying the center of the "Hall of Jewels," which also contains numerous charts and pictures to show the geological nature of the diamond, its occurrence, and its uses. Officials of the company believe the present show is putting in the shade even the remarkable De Beers display at the Chicago Century of Progress Exhibition.

Sir Robert Kotze, the well-known mining magnate, in an article on "The Jubilee of the Rand" in the *Fortnightly*, has produced a little masterpiece of condensation.

"Fifty years ago Frederick Struben was working a small gold mine on the northern flanks of the range of hills known as the Witwatersrand," Sir Robert writes. "The mine was in itself of little significance or value and is now derelict and forgotten. The lode worked was a quartz body such as is commonly associated with gold in parts of the globe. While so engaged he discovered that certain conglomerates (Afrikaans: bankets) in the neighborhood also carried gold, and further search by himself and others soon disclosed that some of the beds—or reefs, as they are called in South Africa—carried the precious metal in highly "payable" quantity. These beds are now known as the Main Reef Series and have yielded by far the largest portion of the gold which has been won on the Witwatersrand."

Sir Robert stands mainly by the delta theory of the origin of the Witwaters-

(*Continued on Page 525*)

ORE FROM THE HEAD CENTER MINE of the Tombstone Development Company, in Arizona, is treated in this 25-ton mill operated by Seabring and Perotti, lessees. The mill contains a jaw crusher, ball mill, and discharge screen and concentrating table. The tailings are treated in the small cyanide plant near by

Arizona

One More Smelter Run at U. V. X.

COMPANY EXPECTS operations to cease this year—Development of zinc deposits near Tombstone

✦ The United Verde Extension mine, although it has raised the wages of over 500 employees, following the lead of the Phelps Dodge Corporation, gave warning that on Dec. 1 operations will, in all probability, be suspended permanently by reason of the exhaustion of ore reserves. The final smelter run is now being planned.

✦ Extensive drilling operations are said to be proposed on the San Juan zinc claims in the Dragoon Mountains northeast of Tombstone. Charles E. Stott, representing the American Metal Company, is on the grounds from the company's office at Shafter, Tex. The San Juan properties were owned by Mrs. Jonathan Gordon, of Tucson, and have been taken over on a conditional agreement by the company.

✦ Keen interest is shown in molybdenum mining in the "Old Hat" district in Pinal County. The Molybdenum Gold Mining Company has acquired several properties and reopened the partly developed claims. About $3,000,000 in gold has been removed from these properties since 1881. Today the dumps are considered "pay dirt," as they contain molybdenum and vanadium. A new crushing unit has been installed and the capacity of the flotation plant has been increased from 200 tons to 400 tons per day. A leaching plant is now being constructed on the site of the old cyanide plant. Fred Marston is manager.

✦ The White Spar Mining Company, operating the Tyro group of seven claims in the Katherine section, 35 miles from Kingman, is maintaining a development program. In 1935 the mine had a production in excess of 5,000 oz. of gold, the ore being milled at the plant of the Gold Standard Corporation. Robert Elgin is superintendent and William E. Whalley and F. Weeks are owners.

✦ A. T. Russell, of Kirkland, has taken over the Henderson mines, owned by the Bragg estate, near Placeritas. A small milling plant has been completed and the property is now producing.

✦ W. A. Woodbury, vice-president and general manager of the Idaho Consolidated Mines Company, announces plans for the installation of a small amalgamation and flotation plant on the old Leviathan mine, at Congress Junction.

✦ General Superintendent I. H. Barkdoll of the Phelps Dodge Corporation Copper Queen branch, at Bisbee, states the Junction, Campbell, and Cole shafts on the property are producing 50,000 tons of copper ore a month. The ore is smelted at the company's reduction plant at Douglas. Approximately 900 men are employed underground and 350 on the surface.

✦ The Tennessee-Schuykill mine, at Chloride, Mohave County, started operations Sept. 14, running three shifts at the mill. About 80 men are on the payroll. The present capacity of the flotation plant is 150 tons daily. Jake Schoder, of Kellogg, Idaho, is in charge of mill operations. R. L. D'Arcy, formerly superintendent of the United Verde Extension, is superintendent.

California

Gold Dredge Operators Organize

TWENTY leading producers plan to advance welfare of the industry—Golden Queen mill capacity increased

✦ A new organization, known as the Gold Producers of California, has been formed by twenty leading gold dredge operators of the State, and headquarters have been opened at 351 California St., San Francisco. F. C. Van Deinse, vice-president of Yuba Consolidated Goldfields, has been selected president of the association, with Richard Smith, general manager of the Natomas company, and Fred Estep, of Snelling Gold Dredging Company, filling the posts of first and second vice-president respectively. A. Knorp is secretary-treasurer. The organization has been formed for the express purpose to protect gold mining and advance the welfare of the industry in general.

✦ Following the installation of additional equipment, milling operations are now conducted at the Golden Queen mill, near Mojave, at a daily rate of from 350 to 360 tons. About 35 tons are shipped daily to the custom section of the mill from the Soledad Extension property near by. W. C. Browning is general manager of Golden Queen Mining Company.

✦ With plans to sink the new shaft to a depth of 1,000 ft., sinking operations are carried on at the Sisley mine, near Penryn, on a three-shift basis. The first level will be at 300 ft., and opening of additional levels at 200-ft. intervals is contemplated. Work on the new shaft was started about two months ago, during which time a headframe, hoist, and compressor equipment have been installed. The mine is operated by the Burm-Ball Mining Company, John Burmeister, general manager.

✦ Amador Mother Lode Mining Company, E. A. Stent, managing director, is reconditioning the 40-stamp mill at the Gover-Fremont property near Drytown, acquired recently. The mill has a capacity of 200 tons, and will be operated on dump material until rehabilitation of the mine has been effected.

✦ Work has been started on the 300-ton mill at the Forbestown holdings of Idaho Maryland Mines Corporation, in Butte County. The new plant at the Midas property will contain a jaw crusher, ball mill and classifier, concentrating tables, and flotation and filtering units. Concentrates will be trucked to the company's cyanide plant at Grass Valley. Good progress is being made

on the new road to the mill site and power line. Operations at Forbestown are under the direction of John Ehrhorn, superintendent.

✦Walker Mining Company, operating the Walker mine and concentrator, in Plumas County, is now milling 1,400 tons of ore daily, with about 400 men employed. H. A. Geisendorfer is general manager.

✦About 85 men are engaged in the erection of the new 9-cu.ft. all-steel dredge at Callahan, in Siskiyou County, by Yuba Consolidated Goldfields. The dredge is expected to be in operation early in October.

●

Jubilee of the Rand

(*Continued from page 523*)

rand gold fields. He says:

"The reader must picture the Main Reef Series as a set of beds like coal seams, but containing, instead of black coal, a conglomerate consisting of rounded pebbles from half an inch to two inches in diameter, embedded in a species of hard sandstone which is brown at or near the surface and bluish when it comes from a depth. The thickness of the beds varies from a few inches to five or six feet and more."

Other points in Sir Robert Kotze's review are as follows:

Among the Rand gold mines are several that rank as the largest gold producers in the world. Half a dozen of them handle over two million tons a year; two of these over four million tons of ore.

At 8,500 ft. on the Rand the rock temperature is about 107 deg. F., whereas it would have been over 200 deg. F. in other parts of the world.

It is hoped to carry on deep-level mining to 10,000 or even 12,000 ft. by the adoption of ventilating fans, air-cooling, and other devices.

The continuity of the gold reefs as they plunge into depths is astonishing.

The last year of the gold standard in South Africa was 1932, and the returns of that year show the following comparisons with those of 1935, for all the gold mines of the Transvaal, which include some relatively small mines outside the Witwatersrand:

Producing Mines

	1932	1935
Tons crushed	35,700,000	45,800,000
Gold, oz. recovered..	11,600,000	10,800,000
Value	£49,100,000	£76,500,000
Dividends paid	£9,000,000	£16,400,000
Taxation	£4,300,000	£14,300,000

All Gold Mines

Salaries, wages	£16,800,000	£23,100,000
Stores	£16,100,000	£25,600,000
Whites employed ...	24,300	34,500
Natives employed ..	228,900	299,200

By the time the industry has doubled its tonnage and expenditure on costs, it will employ 50,000 whites and 400,000 natives, and the population of the Rand will be 50 per cent higher than at present.

Utah

Park City Consolidated Sinking to Deeper Levels

THREE-COMPARTMENT shaft to be sunk to develop ore found on 950 sublevel—New company to operate Monarch lead mine.

✦A loan of $60,000 has been made by the United States Smelting, Refining & Mining Company to the Park City Consolidated Mines Company, of Park City, for the sinking of the three-compartment shaft from the 900 to the 1,200 level and for drifting on the 1,050 and 1,200 levels to develop the ore recently opened up on the 950 sublevel. Shaft sinking has been started. The grade of the ore opened on the 950 sublevel is said to carry 30 to 40 oz. of silver to the ton, 3 to 6 per cent lead, and 6 to 10 per cent zinc. Gloyd M. Wiles, superintendent, has been promoted to the position of general manager.

✦Lakeside Monarch Mining Company has been organized by George H. Short, Salt Lake engineer, to operate the Monarch mine, on the southwest shore of Great Salt Lake, 16 miles from Delle, a station on the Western Pacific Railroad. Associated with Mr. Short in the enterprise will be Lawrence Fox, J. D. Shilling, Dr. Ralph T. Richards, Leland Kimball, Louis E. Arnold, H. Ross Brown, and the American Smelting & Refining Company. Operations by Mr. Short indicate the existence of a well-defined channel 20 to 35 ft. wide, wherein an orebody estimated to contain 100,000 tons containing 13 per cent lead has been blocked out. The company plans to build a mill for the treatment of the low-grade ore. During the years that Mr. Short has carried on development, about 5,000 ft. of development work has been done and 5,000 tons of crude ore has been shipped. The fissure has been traced, according to Mr. Short, for a mile and a half on the company's ground. The ore occurs in the Ajax limestone in fissure and bedded deposits.

✦The recent dividend of the Silver King Coalition Mines Company, operating at Park City, will represent an increase of 5c. a share. Since Oct. 1, 1934, the dividend rate has been 10c. a share. That paid on Oct. 1, 1936, will be for 15c. a share, or a total of $183,070.05, increasing the total of dividends produced by the properties of the company to $27,198,795.55.

✦The dividend of the Mammoth Mining Company, operating in the Tintic district near Eureka, payable Oct. 1, will be for 5c. a share or $20,000, bringing the grand total of dividends up to $3,218,251.

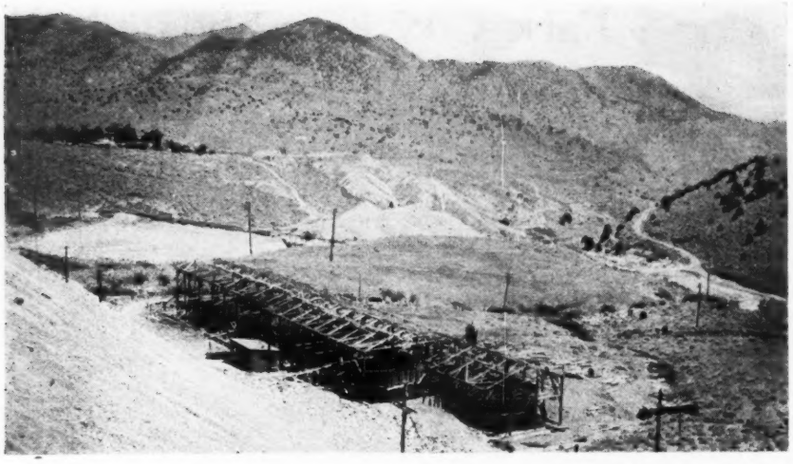
✦Reopening of the Murray lead smelter of the American Smelting & Refining Company on or about Oct. 15 is planned, according to W. J. O'Connor, general manager. The plant was closed down last July to allow for an accumulation of ores in the stockpiles before resumption of operations for the usual fall, winter, and spring run.

✦Operations at the Tintic Ophir Mines Company in Ophir Canyon, 55 miles southwest of Salt Lake City, have been expedited by the completion of a mile and a half of road by the Harry L. Bracken Contracting Company. Work of the company under the direction of Manager F. E. Porter is being centered in the Buffalo tunnel, to cut the downward continuation of the rich oreshoots productive of between $3,000,000 and $4,000,000 since 1870. Several shipments of high-grade ore have been made by Joseph E. Purcell and J. Jack Braeckel, of Denver, Colo., who have a five-year lease on a large area of ground. Samples taken from the first three carloads shipped assayed from $3 to $6 in gold, 81 to 602 oz. of silver to the ton, and from 6.8 to 33.7 per cent lead.

✦Barber and St. Jeor have opened a body of bedded ore carrying values of $40 in silver and lead to the ton. The company on its own account is advancing the Buffalo tunnel 400 ft. west to reach the faulted portion of the Chloride Point fissure, displaced by the Gladstone fissure to the north. A 14-ft. bed of limestone is also being followed across the apex of the Lion Hill anticline, to cut six parallel tissures, including the Gladstone.

✦St. Clair Brothers are driving an adit on the Northern Light claim to open a horizon productive in the northern end of the Tintic Ophir estate. Ore taken from the Kelly lease, 1,100 ft. west of the Chloride Point tunnel, carries high values in gold, silver, and lead. Later, when it gets its orebodies and fissures well outlined in the upper workings, the company plans to reopen the Three Metals tunnel, 400 ft. vertically below the Buffalo tunnel to prospect the Empire, Clipper, and Chance fissures, which were large producers in early days in their upper horizons. J. R. Walker is president of the company and Earl B. Young, consulting geologist

✦In Big Cottonwood Canyon shipments are being made steadily from the Cardiff mine. J. H. Deming, secretary-treasurer of the adjoining Howell mine, reports that a considerable body of manganese ore has been struck in driving the American Metal tunnel to reach Howell ground. Leasers working in the Baby McKee claims shipped a 53-ton lot of ore recently.



NEW CYANIDE PLANT of the Arizona Comstock Company, at Virginia City, is nearing completion. It will treat the sands from refloated accumulated tailings and the tailings from concentrates

Nevada

Mill at Mountain City Copper Starts Operations

HIGH-GRADE COPPER ore sent direct to Tooele smeltery.

✦ A new 300-ton flotation mill has started crushing ore on a one-shift basis at the Rio Tinto mine of the Mountain City Copper Company, in northern Elko County. Mountain City Copper is a subsidiary of the International Smelting Company, controlled by Anaconda Copper. Ore of high grade from the oxidized zone, above a depth of 280 ft., has been trucked at the rate of over 100 tons per day to Mountain Home, Idaho, and some to Elko, Nev., thence by rail to the smelter at Tooele, Utah. It was indicated that the shipment of ore will continue as long as the roads remain open and the mill will treat the sulphide ore. The major equipment in the mill consists of one 15 x 24-in. Traylor mill, two 4-ft. Shorthead Symons cone crushers, an 8 x 6 Marcy ball mill, a Dorr classifier, 12 Fahrenwald flotation machines, three 60-ft. Dorr tanks, and two 12-ft. American filters.

✦ From its open-cut operation on the outcrop of the Comstock lode, the Arizona Comstock Corporation since mid-1933 had treated to the end of last month 223,665 tons of highly oxidized ore having a gross value of $5.99 per ton, with gross recovery of $1,639,049. Receipts for ore and concentrate were $1,045,473 and impounded tailing had a value of $463,144. For the first seven months of 1936, total costs, before depreciation and depletion, were $3.08 per ton. Mill feed has been increased to 11,000 tons per month and concentration is at the rate of 210 tons to one. August concentrate was valued at $2,174 per ton and was shipped direct by truck to the Selby smelter. Mill equipment includes 44 Kraut and 8 Denver Fahrenwald cells, with a cyanide unit that hereafter will treat part of the concentrate. Impounded tailing will be refloated and the sand will be treated in the 500-ton cyanide plant now under construction. A larger primary crusher and coarse-ore bins of 2,000 tons' capacity will be provided.

✦ Silver ore is being shipped to a smelter from the property of the Secretary Lode Mines Company, lying between the Northern Belle and Mount Diablo mines, at Candelaria, a prolific early-day silver district in southern Mineral County. Mark Bradshaw, of Tonopah, is in charge.

✦ The Jumbo mine, in the Awakening district of Humboldt County, opened by George Austin, his brother Jesse, and two sons, continues a center of wide interest and extravagant publicity, to which members of the Austin family have not contributed. The Austins have started crushing ore in their new 30-ton amalgamating and concentrating mill, having completed a new road from the valley floor to the tunnels, high on the mountain. They report production to date of more than $100,000 in ore shipped and in bullion from their 2-ton "coffee" mill that has treated only the richest gold ore. A mine car and track have been provided for the lowest tunnel, all work heretofore having been done with hand steel and wheelbarrows. Several hundred claims have been filed on in the surrounding area and a number of groups have been optioned, in some instances to active companies or operators. J. B. Haffner, manager for the Consolidated Coppermines Corporation, has a crew of men at work on an option group near the Austin property, and B. F. Hanna, director of the Standard Oil of California, who first visited the district in company with Herbert C. Hoover, has installed a compressor on his optional claims.

✦ The efficient 75-ton cyanide mill of the Circle Gold & Silver Mines, Inc., at Gold Circle, Elko County, has been running two shifts on ore said to be of high grade and coming in part from leases and from the Esmeralda mine, in the eastern part of the district. Late revenue from the mill was said by N. H. Getchell, manager, to have liquidated current indebtedness and early expansion was predicted.

✦ Lessees have been shipping a substantial volume of silver-gold ore from the Nevada Wonder mine, at Wonder, Churchill County, the bulk of the product going to the International smelter, in Utah. Reports indicated that orebodies of some importance had been opened in late development on intermediate levels from the old shaft.

✦ At a meeting of stockholders and creditors of the Como Mines Company at Carson City recently, J. Dryden Kuser was made trustee under the direction of the Federal District Court. Officers have been in New York to confer with some of the larger stockholders over plans to liquidate the company's indebtedness and reopen the mine and flotation mill. An independent engineer was retained to sample the mine workings and ascertain if available ore warrants the resumption of operations.

✦ Plans are announced for early construction of a 100-ton custom flotation mill in the old Groom district, in southwestern Lincoln County, at one time a notable lead-silver producer. Several of the old mines have been reopened. L. D. Prettyman, of Baltimore, Md., has been one of the active factors in the district's revival.

✦ Production of dumortierite has been increased from property of the Champion Sillimanite Company near Oreana, Pershing County. The company is controlled by the Champion Spark Plug Company, the founder of which, Dr. J. A. Jeffery, inspected the dumortierite deposits lately. He said this deposit was the most important in the country. The same company produces quantities of andalusite from deposits near Bishop, Calif. Most of the dumortierite has been recovered in the form of boulders, scraped from the surface with a dragline device, but preparation has been made to mine the ore underground during the winter months.

✦ Old mines and new prospects at Kennedy, at one time productive of rich silver ore in eastern Pershing County, are attracting operators and prospectors, several having resumed production of shipping-grade ore.

NEWS FROM WASHINGTON

By Special Correspondent

OCTOBER comments from Washington should all begin with a capital "IF." And the doubt, of course, is based on election assumptions. Almost every important economic and political factor from the capital city will affect mining and minerals more or less according to the results of balloting on Nov. 3.

The differences to be "settled" by this balloting relate not so much to objectives as they do to means of reaching them and to the philosophies of government relation to business. One need not assume that it is a controversy between democracy and autocracy. It is only necessary to recognize, so far as business problems are concerned, the very important distinction between Roosevelt's near-paternalistic participation in business decisions and Landon's philosophy of "umpiring" but not participation. Almost all the controversial differences trace back to these fundamental contrasts between the premises of the New Deal and those in Landon's type of Republicanism.

Competition Control

The more intimate the studies made of legislative and administrative regulation of business competition, the more appalling becomes the evidence of prospective disappointment. Washington is gradually beginning to believe that the Robinson-Patman Act, though it becomes a continuing annoyance to buyers and sellers alike, will no more serve completely to regulate business dealings than has the Sherman Law or the Clayton Act. Even without the curtailment which courts undoubtedly will impose on the Federal Trade Commission's control, there is little prospect of vigorous and effective administration, and all for reasons that have nothing to do with either the zeal or the ability of F.T.C.

Three objectives of public service are distressingly scrambled, with a resulting group of mutually incompatible objectives. Protection of the consumer will demand forcing down of prices. Protection of small producers and dealers demands a stabilization of prices on levels well above those necessary for big units of business. Elimination of needless small operators would bring these irreconcilable objectives closer together, but would then defeat the third objective of preventing monopoly by regulation.

It is probably most important from the standpoint of mining to appreciate that the fundamental competition which is important to the public is today competition between geographic areas or between different commodities—copper and aluminum for example. Competition between individual companies probably has less to do with pricing than a half dozen other economic factors. Congress either cannot or will not draft legislation recognizing this. Washington, therefore, expects a perennial rash to irritate mine executives whose affairs happen to come under the notice of F.T.C. investigators, through complaint or otherwise. Like poison ivy, the result will be very uncomfortable but certainly not fatal in any but rare cases.

Budding Boom?

● Washington is more entertained than worried by the extravagances of "boom" or "disaster" current in political forecast. In the same papers it reads of Vice-Presidential Candidate Knox calamity howling on behalf of savings banks and insurance companies. It takes him no more seriously than it does Secretary of Commerce Roper, who grieves publicly over the danger of the industrial booms which now threaten to establish a basis for another great depression.

Mining can still safely count on a steady, but not spectacular, increase of business activity during the coming months. Election returns may materially change psychology, but they are not likely greatly to change the quantity of business to be done in minerals for some months to come. The long-run effect expected depends, of course, on the partisan leanings of the expecter.

Spanish Troubles

Neutrality legislation of the United States does not apply to the merchandising of munitions to belligerents in such a circumstance as the present Spanish revolt. Only when two separate nations are in conflict does the law require or authorize the President to embargo sales. Nevertheless, those wishing to sell mineral products either to Loyalist Reds or the revolting Fascisti are frowned on by the State Department. "This Government's well established policy of non-interference with internal affairs in other countries" is cited by the Assistant Secretary of State as ample reason why American business should not sell to either party in Spain.

Probably more significant to American mineral producers is the interruption of supply of pyrites and other important mine products. American producers of sulphur have been scurrying about trying to glean new business in markets previously filled by Spanish pyrites. Like effort is, of course, logical with respect to all other important Spanish exports. Other such mineral commodities exported in recent years in substantial quantities are: Iron ore, copper ore and pyrites, zinc ore, pig lead, and quicksilver. Washington is perhaps most concerned over the possibility that Spain and Italy both might interrupt quicksilver shipments, curtailing the supply of a strategic mineral important for United States industry.

Still greater concern would, of course, attach to any actual participation by other nations in the armed controversy. During the early weeks of the revolt Washington rather held its breath; but the unexpected restraint of partisan neighbors has lulled apprehension. Nevertheless, Washington regards the Spanish controversy as so fundamental a battle between conflicting philosophies of government as to make the situation an open keg of gunpowder about which sit careless smokers flicking hot ash.

"Yardstick" Power

Speaking to the World Power Conference during September the President promised to continue throughout his régime the development of Government "yardstick" enterprises to cheapen power supply. Public utility executives were, of course, much distressed, but there was no justification for surprise. At no time has the New Deal in any way abandoned its effort to force by one means or other, by direct competition if necessary, the lowering of prices for power to the householder. As a step toward that, the Government aggressively seeks a lowering of the prices for power to industry.

Several recent contracts made by TVA for the sale of large blocks of power to electrometallurgical and electrochemical enterprises in the Valley illustrate the lengths to which even "anti-industry" leaders will go to achieve the major objective of power cheapening. One of these contracts with Aluminum Company of America represents a "consorting with the enemy" of outstanding significance.

Like developments of marketing of

power at Boulder Dam, at the Bonneville, Oregon project, and at others will have greater importance to the mining industry. (In this connection, see "New Manganese Method," *E.&M.J.*, Sept., p. 477, where 1.5-mill power is discussed.) The problem of pricing at Bonneville has, however, not significantly changed in several months. (See *E.&M.J.*, June, p. 308.)

More Beryllium?

The recent forecast of the Bureau of Mines that beryllium production will probably be increased this year by entry of a third important manufacturer occasioned questioning at the Washington headquarters. The two former producers were Beryllium Products Corporation, now operating at Temple, Pa., and Brush Beryllium Corporation, Cleveland. The large chemical company "expected to engage in the production of beryllium in 1936" is now stated by the Bureau to be Westvaco Chlorine Products Company, Charleston, W. Va.

Apparently, the Bureau comments have been over-interpreted by some readers. Bureau officials explain that they did not intend to imply any change in the order of magnitude of beryllium production, nor any such large cuts in price as have accompanied abrupt change in production activity in other mineral industries. The "wholesome growth" which has been going on is expected to continue; but lack of any huge mineral reserves to support the industry seems at present to prevent more rapid expansion. Future prices comparable with those of silver are to be expected, according to some unofficial comment.

Labor Standards Imposed In Government Contracts

If, after Sept. 28, 1936, you enter into a contract with the Federal Government "for the manufacture or furnishing of materials, supplies, articles, and equipment, in any amount exceeding $10,000," your transaction will come under the terms of the Walsh-Healey Act providing for observance of certain labor standards. In this manner the Government is perpetuating to a limited extent the labor provisions of NRA.

In accepting any contract as defined above, the contractor must stipulate that (1) he is the manufacturer of, or a regular dealer in, the materials or articles to be manufactured or used in the performance of the contract; (2), all persons employed in the performance of the contract will be paid at least the minimum wage determined by the Secretary of Labor to be the prevailing minimum wage for persons employed on similar work; (3) employees engaged in fulfilling a contract shall not work more than 8 hours a day, or more than 40 hours in one week; (4) neither convict nor child labor will be used; (5) working conditions shall not be unsanitary or hazardous or dangerous to the health and safety of employees engaged in the performance of the contract.

It is not expected that items 1, 3, 4, and 5 will put any undue burden on manufacturers. Few industries are today violating any of those provisions. But when it comes to setting a prevailing minimum wage, which the Secretary of Labor is directed by law to determine, there is likely to be dispute and controversy. In fact, it is quite possible that there will be less competition in Government work if contractors have to take orders from the Secretary of Labor with respect to wage scales and other working conditions.

The purpose of the wage provisions, according to Secretary Perkins, is to prevent substandard firms which make a practice of cutting wages below the prevailing standards, and thereby securing an unfair advantage in labor costs, from underbidding firms whose labor standards conform to a sound standard of general practice. They are aimed to put an end to the practice of bid-peddling on Government contract work—a practice which has permitted brokers to sublet portions of Government contracts to substandard factories or sweatshops at prices which enable the principal contractor to make sizable profits without doing the work or maintaining the stock.

Wage determinations will be made only after public hearings at which all interested parties in particular industries or groups of industries will be given notice and opportunity to attend and present evidence. No decision will be made with respect to the geographic differentials until after evidence has been received at such hearings. The Department of Labor will not arbitrarily adopt the minimum wage provisions once contained in the codes without inquiry into present conditions. Several months must elapse before minimum wages have been ascertained for every industry.

Labor Trends

● Greater success in restricting the number of pre-election strikes has been achieved by the President than Washington expected. But union men celebrated Labor Day last month in two bitterly hostile camps. This is going to lead to serious trouble immediately after the election. Marked increase in the number of strikes of important industry is freely forecast in Washington regardless of the result of balloting.

The division of labor into two groups—C.I.O. versus A. F. of L.—has been most significant politically in the reduction of the unity of political action which might otherwise have supported the New Deal. Next month all will know the result.

New Potash Process

Interesting possibilities of making potassium sulphate are suggested by a discovery of the Reno station of the United States Bureau of Mines. It has been noted that by fusing together borax and alunite there results a melt which solidifies in two layers. The lower heavier layer is practically pure potassium sulphate and contains almost 100 per cent of the potash in the original mineral. All the rest of the constituents of the melt form the other more bulky layer.

No appraisal has yet been made of the possible economic significance of this observation. It is suggested, however, that perhaps this will make possible direct production of potassium sulphate at a price permitting shipment from the Intermountain country, where such process would most logically be applied to alunite. The Bureau is continuing further small-scale experiments in order to define the limitations of composition under which this separation will work.

More Tariff Cuts

State Department officials promise to undertake the negotiation of at least a dozen more bilateral trade agreements to adjust tariffs with a corresponding number of countries during the next nine months, before this authority of the President expires. The only important negotiations from the standpoint of mining which have previously been announced were negotiations with Italy and Spain. Obviously, neither of these nations is now a good prospect.

Critics and friendly skeptics both doubt whether any important other industrial nations will care to negotiate seriously soon. However, it is just as likely that a small nation treaty may become important with respect to an individual commodity, since the results of any such agreement become automatically applicable to practically all of the nations of the world when effective for one, no matter how small.

The State Department, quite independent of political considerations, has been making a sincere effort to defend its negotiating technique as well as its results. Such defense arguments sound just as "logical" as the criticism; but the fact is that tariffs are rarely a matter of logic. No matter how reached, the decisions are social in nature; and the implications are usually partisan; and the decisions are commonly logrolled, in derivation.

Tri-State

Zinc Production Increases

GREATER ACTIVITY and expansion programs being followed in various districts.

✦ Major mine and tailing-mill companies of the Tri-State zinc and lead district, which have been holding production down to a 50 per cent basis through July, August, and part of September, have stepped up operations to around 80 per cent of normal and hope to continue at that rate, or higher, for the remainder of the year. Mining men envisage a much brighter future for the industry and are going ahead with more ambitious programs for expansion than has been witnessed for many years.

✦ Frank Childress, of Joplin, who sponsored the dewatering program in the old Oronogo-Webb City district, has leased more than 7,000 acres of land in the old Alba-Neck City district, in Missouri, and is carrying on an extensive development campaign. Three drill rigs have been moved into that old field and two additional rigs will be placed in operation soon. Drilling so far has proved encouraging. Rich ore, below the lowest mine levels in the Alba-Neck City district, has been found in a number of holes. Mr. Childress has also leased a considerable acreage in the West Joplin district, on which he is drilling.

✦ Eagle-Picher Mining & Smelting Company, which has most of the acreage in the old Webb City-Oronogo district under lease, has almost completed the dewatering of the North Webb City district and may extend its pumping operations further in Missouri, according to Clint Niday, of Picher, general superintendent. The Eagle-Picher company is also operating several drill rigs in the old Missouri district with the view of extending its ore reserves.

✦ St. Louis Smelting & Mining Company has started a shaft on the Bailey land, south of the Ballard mill, southeast of Baxter Springs, according to H. H. Utley, of Baxter Springs. The company recently completed a shaft on the Clark lease. These developments indicate that within the next year the St. Louis company may make the Ballard mill into a central plant for the treatment of ores from the various leases in the West Baxter district.

✦ Commerce Mining & Royalty Company is drawing plans for the enlargement and improvement of the Bird Dog mill, the second largest plant in the district, according to W. M. Harrison, of Miami. The company is now having built 36 cells of Mineral Separation flotation equipment, which will replace the 12 Butchart float machines now in the plant. This change will greatly increase the capacity of the float department and it is expected that other departments will be increased during the next few months. The Bird Dog mill will, when enlarged, be capable of treating about 150 tons of ore an hour and it will operate as a central mill.

✦ The Cortex-King Brand Mines Corporation is sinking a shaft on the Bullfrog lease, east of Century, Okla., according to W. T. Landrum, of Baxter Springs. The company has developed some good orebodies on the lease in the past several years, and may decide to rebuild the old mill on the property soon.

✦ Earl Childress, of Baxter, has obtained a lease on the Oronogo cemetery tract from the city of Oronogo, and is erecting a derrick and hopper on a near-by shaft. The ore will be shipped to the Central mill of the Eagle-Picher, provided an injunction is not obtained to block the operation. Eighteen years ago citizens of Oronogo prevented mining under the cemetery when they obtained a permanent injunction against W. Guy Waring and the Oronogo Mutual Mining Company.

THE GRANT MINE PIT, in St. Louis County, Minn., was recently drained of its accumulated water to permit mining of iron ore. The water reached a height almost to the top of the boiler stack in the foreground

Iron Country

Prospecting in the Western Mesabi

IRON PRODUCTION continues at a high rate—Iron paving blocks proposed

✦ That additional ore may be required in the near future is indicated by new activity on the west end of the Mesabi range. The M. A. Hanna Company has taken option on the Greenway mine, near Grand Rapids, Minn., and some churn drills for structure drilling are being installed at the Jordan mine, near Lake Pokegama, by the R. S. Archibald interests from Negaunee, Mich.

✦ After three years of testing, agitation is again active on the Mesabi range to use iron block paving as another outlet for iron ore. The county commissioners of St. Louis County are being petitioned to set aside $20,000 to install such pavement on the range next summer, with additional sections to be added as it proves its superiority over other types of paving blocks now in use.

✦ Iron-ore production continues to be heavy, with no sign of a decrease until the freeze-up occurs this fall. Due to lack of space for ore on the Lower Lake ore docks, shipments are not going forth as planned, and it is hoped the cold weather holds off until at least Dec. 1.

✦ New equipment purchased this spring for the St. Paul mine of Republic Steel Corporation at Keewatin is now operating with the exception of the electric haulage line from pit receiving pocket to washing plant. As the ore to be shipped for the next month is direct-shipping, ample time will be secured to complete the haulage. The two 7-RD Caterpillar tractors with 10-yd. Athey crawler wagons can keep the 30-in. belt conveyor, 900 ft. long, in ore with only one of the two 1¼-yd. Marion gas shovels in operation. This allows the second machine to be used as a dragline on clean-up and stripping work.

Mexico

New Mining Laws Proposed For the Industry

STATUTE MAY REQUIRE one-quarter of profits to be invested in Mexico and a 5 per cent royalty on gross revenue—More strikes

✦ Fall found the Mexican mining industry full of mixed activities. The labor problem loomed larger, bringing with it some strikes, most important of which is that of 1,748 employees of the Los Morales smelter, San Luis Potosi, of Cia. Minera Asarco, for higher wages and other benefits for workmen. The Federal Board of Conciliation and Arbitration classified this strike as existant, as all the strikers voted for it. There were some interesting court decisions. Some companies settled labor troubles by raising wages at a considerable increase in operating expenses. New operations were started in several regions.

✦ The Ministry of National Economy announces the preparation of a new mining law which features: investment of at least 25 per cent of their profits in Mexico by mining companies; expansion of federal mineral reserves; greater preference to Mexicans in mining, and abolishing mining taxes, substituting for them a 5 per cent royalty for the government on gross revenues of operators. This measure is soon to go to Congress.

✦ Organized small-scale miners and mining companies recently held their first national convention in Mexico City, with about 225 delegates attending, among whom were several foreigners. Resolutions were adopted urging the federal authorities to establish a financing bank for small-scale mining industrialists who will put up 5 per cent of the funds for the institution as royalty on their gross income basis; to reconstruct old roads to facilitate movement of ore and other materials, and to forbid the railroads to raise freight rates on ores. The meeting appointed a permanent executive committee to press these resolutions and to arrange for staging a general convention of the mining industry in Mexico City next January.

✦ The Federal Supreme Court established a precedent concerning interpretation of the mining phase of the public services policy in refusing Joseph H. Weitter an injunction against enforcement of the order of the ministry that he devote 20 per cent of his mill capacity in the Totolapam district, Guerrero, to treating ores produced by small miners. The ministry granted him the right to operate the plant for ores from five mines of the Balsas Mining Company. It recently ordered him to treat ore mined by small miners and denied him the right to treat his ore exclusively. Weitter argued that his franchise antedates the law of April 20, 1935, which declares that all metal-treatment plants in Mexico are public utilities. The Court agreed with plaintiff's contention, but held that public interests must be preferred to private, even if the law must be made retroactive to accomplish that.

✦ Preparations are being made by La Consolidada, S. A., an American-owned Mexico City metal works, to establish a foundry and metal plant on 250,000 sq.ft. in Piedras Negras, Coahuila, at a cost of 1,000,000 pesos (about $280,000 U.S.).

✦ The national administration has agreed to lend 1,000,000 pesos for establishing a smelter at Mineral de Bonanza, near Concepcion del Oro, Zacatecas, for organized gambusinos (prospectors) and small-scale miners. As now planned, the plant's capacity will be from 200 to 500 tons daily and it will employ about 1,000 men. The loan will be repaid by a small percentage of proceeds from smelter output.

✦ Asarco Mining Company has arranged to employ miners laid off due to closing of its San Geronimo Taviche unit, in Oaxaca, because of unprofitable operation, at its units in El Oro, Pachuca, and Teziutlan. Free transportation to new working bases was given the miners and their families and in addition the workers were compensated for tons of ore reserves.

✦ The strike at the San Luis Potosi smelter of the American Smelting & Refining Company is estimated to effect a curtailment of lead production amounting to about 1,000 tons monthly.

✦ Favorable progress in settling labor difficulties that have beset Cia. Minera Minerva y Anexas, S. A., operating at Asientos, Aguascalientes, is being made, according to the federal labor department. Jeronimo Elizondo is president of this company. The workers want higher wages and other concessions, which, the company contends, are beyond its economic capacity to allow.

Canada

Underground Mill for Big Missouri

BRITISH COLUMBIA'S mining districts active—Allenby copper mine reopened.

✦ An underground mill having a capacity of from 500 to 750 tons daily is to be constructed at the Big Missouri mine, Portland Canal district, according to an announcement recently by W. M. Archibald, vice-president in charge of mines for Consolidated Mining & Smelting Company. So far as is known, the mill, which will be built at a maximum depth of 200 ft. beneath the 2,300-ft. level, will be unique. It will solve the problem of operating through a severe winter, and it is understood will save the expense of hauling the ore a considerable distance to a suitable millsite. Construction of an aërial tramway and several miles of road through rough country will also be avoided. A dam is being constructed at Long Lake for the development of hydro-electric power, and the main road extending 5.3 miles into the mine is being rebuilt by the provincial government.

✦ A proposal to reopen its copper mines and 2,500-ton concentrator at Allenby was accepted by the stockholders at a special general meeting of Granby Consolidated Mining, Smelting & Power Company in New York on Sept. 29. The plants were closed in 1930, but have been maintained in good condition. The company will concentrate production from the Copper Mountain mine, which is estimated to contain about 9,885,000 tons of ore reserves.

✦ As a further reflection of the improvement in the copper market, C. P. Browning, general manager of Britannia Mining & Smelting Company, announced recently a general increase in wages. Men formerly earning more than $3.75 receive an increase of 50c. a shift, and those formerly earning less than $3.75 receive an increase of 35c. Wages to Orientals have also been advanced 25c. a shift. Nine hundred men are now engaged at the Howe Sound operation, compared with an average of 575 last year.

✦ Output at the Bralorne mine, at Bridge River, was valued at $209,300 in August, a sum greater than the value of production for any previous month; 14,449 tons of ore was milled and 5,980 oz. gold produced. The increase in production is attributed to the larger proportion of ore drawn from the higher-grade bodies in the Empire workings.

✦ Ore for a length of 287 ft. has been opened at the eighth level at Wayside, according to the managing director, P. E. Ritchie. One section in the north drift, 60 ft. long, carried an average of 0.36 oz. gold across a width of 3 ft. and

another, 45 ft. long, averaged 0.41 oz. across 3 ft. 8 in. The outlook at the property is considerably improved by this development and mill capacity will be increased from 150 to 200 tons.

✦ Ore reserves at the Minto are estimated to be 40,000 tons averaging 0.30 oz. gold by the manager, D. N. Matheson, in the recently issued annual report. The value of output in the year ended June 30, 1936, was $230,471 and net profit was $15,349.

✦ At the Island Mountain mine, in the Cariboo district, 3,841 tons of ore was milled in August and 1,398 oz. gold produced, valued at $48,930. The president of the operating company, F. W. Guernsey, reports that the shaft has been sunk 350 ft. below the main adit tunnel. Stations are being cut at 150-ft. intervals, and lateral work will be commenced when a depth of 500 ft. is attained.

✦ From the inter-glacial deposit at Wingdam, the Consolidated Gold Alluvials recovered 559 oz. gold in August, valued at $19,656. The managing director, Ian C. Sanderson, states that as actual recovery has not been consistent with sampling, previously issued estimates of pillar reserves should be discounted by about 40 per cent.

✦ At the Vidette mine, in the Kamloops district, 724 tons was milled in August, according to the managing director, G. F. Dickson, and 609 oz. gold, 900 oz. silver, and 1,200 lb. copper produced, valued at $21,793.

✦ Gold Mountain Mines, at Hedley, is planning the construction shortly of a 50-ton flotation mill and a 3,200-ft. aërial tramway, according to N. C. Ecclestone, director.

✦ The new 50-ton cyanide plant at the Bayonne will probably be ready for operation before the end of October. In the meantime, the mine is being prepared for production. Seventy men are engaged. Grull-Wihksne Gold Mines, which last year acquired a half interest in the company for $115,000 in cash and machinery, has agreed to advance a further $50,000 in return for 500,000 shares.

✦ In the Ymir area, at the Yankee Girl, 4,107 tons of ore was milled in August, from which bullion to the value of $39,372 was produced. Smelter returns were $35,571. It is expected the new 100-ton flotation mill at the Wesko will commence operations early in October. Arrangements have been made for the provision of an additional $40,000, which will enable a cyanide plant to be installed forthwith. A controlling interest in Durango Mines, operating the Howard property, has been acquired by Dentonia Mines, Ltd., and operations have been resumed. It is understood that Major A. W. Davis will be in charge.

Colorado

Long Tunnel Projected In San Juan

ORE EXTENSIONS of several veins will be determined.

✦ American Smelting & Refining Company has contracted with Shenandoah-Dives Mining Company to drive a long crosscut from the main level of the Shenandoah-Dives mine to the Silver Lake Basin, to explore the Silver Lake, Iowa-Tiger Mines, and intervening territory, at a depth from 400 to 1,000 ft. deeper than any of the present working levels. The new crosscut may be driven more than 3,000 ft., and will make possible development of these mines in depth.

✦ Campbird Limited and King Lease have completed the rebuilding of their mill and are now in full operation.

✦ Shenandoah-Dives Mining Company has completed its modern automatic sampling plant in connection with its custom milling operations. The company is increasing its milling capacity from 600 to 700 tons per day.

✦ The American Smelting & Refining Company is reported to have started another furnace at its Leadville smelter.

✦ J. C. Fitzpatrick, who is operating the Arapahoe, in the East Argentine area, Georgetown, recently let a contract for a tunnel which will facilitate development of the two veins on the property.

✦ The Mattie mine, in the Idaho Springs district, is increasing its milling capacity. This property is developed through the Mattie inclined shaft, the Newton inclined shaft, and a 3,000-ft. tunnel, from which the company will increase mine production.

✦ The Mutual Gold Mining Trust Syndicate, with James Girardet and Dudley Wilson in charge, has recently opened up a 4-ft. vein of good ore on the Lone Star property of the Le Clair Mines Company in Cripple Creek.

✦ Harry Leach has been appointed safety supervisor of the Carleton Interests in the Cripple Creek district, which covers the Ajax, Cresson, Vindicator, Theresa, Elkton, Portland, Gold-Dollar, Doctor Jack Pot, Anchoria-Leland, Rose Nichol, Wild Horse, and other smaller mines. His duties will also cover the Midland Terminal Railroad and the Pike View mine, at Colorado Springs.

✦ Deepening of the larger mines in the Cripple Creek district, below the Roosevelt tunnel is being done rapidly at great expense. The Cresson mine has finished unwatering to the eighteenth level, where good ore was found. The Vindicator mine is mining a good grade of ore on the company's 21st level. The Ajax mine report excellent ore from the 23d level, which is about 350 ft. below the level of the drainage tunnel. Orebodies found in these levels indicate the need of simplified drainage, as pumping from these depths is expensive.

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Higher Wages for Michigan Miners

QUINCY MINING COMPANY will reopen copper mine closed since 1931

✦ The Calumet & Hecla Consolidated Copper Company has announced a general increase of 10 per cent in wages and a bonus of $12.50 for each employee. Approximately 1,800 employees will be affected. The increase will be effective Oct. 1, and the bonus, equivalent to the current dividend of 25c. per share on 50 shares of stock, was paid with the Sept. 30 payroll disbursement. This is the second wage increase announced by the company within the last year. On Nov. 29, 1935, the minimum rate was increased approximately 15 per cent and all employees on an hourly rate were given an increase of 5c. an hour.

✦ The Copper Range company also has announced an increase of 10 per cent in wages for all employees of the mines, mill, and smelter, effective Oct. 1.

✦ Directors of the Quincy Mining Company have decided to reopen the mine, which has been closed since September, 1931. To make this possible, an assessment of $2.50 per share has been called, payable in two equal installments, Oct. 20 and Jan. 16. This will make the total paid in $24.50 per share. Par value is $25 per share. The mine is in good condition, and has been extensively developed, and it is believed production can be in full swing after the shafts are reopened.

✦ Prof. A. T. Sweet, formerly of the Michigan College of Mining and Technology, in Houghton, has been appointed director in charge of a mineral research project in the Upper Peninsula of Michigan, to be financed and operated by the Works Progress Administration. The project will employ 56 qualified men, in copper and iron research. Most of the experiments will be conducted at the Michigan College of Mining and Technology.

HEADFRAME AND CRUSHING PLANT at the Hecla mine, at Burke, Idaho. The dragline shovel near the crushing plant is excavating for foundations of the new 750-ton mill, which will treat ore from the Star mine

Idaho

Developing Gold and Tungsten Deposit in Murray District

FORMATION expected to contain ore in depth—Mineral Mountain nears deeper objective

✦ The Four Square Gold Syndicate, in the Murray district, is now down 465 ft., with plans made to sink the shaft to deeper levels. In the opinion of geologists in the Northwest, the deeper formation is considered favorable for the deposition of orebodies. The Four Square has carried out extensive operations on its main tunnel level, proving the vein systems, and has found commercial ore containing gold and tungsten. The management has mapped out a deeper development program and the shaft is the first deep one projected in the Murray gold area.

✦ President Stanly Easton announced on Sept. 28 that the solarium at the Bunker Hill & Sullivan mine at Kellogg was open for the fall and winter season. Employees and their families may take treatments and children in the grade schools are permitted the use of the solarium on certain days of the week. The treatments are in charge of experienced nurses.

✦ A crosscut driven south from the main drift in the Mineral Mountain property on Spring Gulch is nearing the downward extension of a vein developed in upper levels. The property has three well-defined vein systems in proximity to the Polaris fault, all of which contain silver. The first vein has been opened for several hundred feet in the deeper workings and shows a width of about 30 ft., carrying a mineralized filling of siderite, quartz, and some gray copper.

✦ A dividend disbursement of 50c. per share, totaling $744,410, on the outstanding 1,488,821 shares, has been ordered by the directors of Sunshine Mining Company. This is the regular quarterly dividend and is the third of similar amount paid during the current year. Total dividends to date, including his disbursement, are $6,757,266. For the six months of the current year ended June 30, the mine had a net profit of $1,499,141 after depreciation, Federal income taxes, and other charges had been deducted. This profit is on the 1,488,821 issued shares, more than one dollar per share for this period. Current assets as of June 30, including $918,716 in cash and $401,103 marketable securities, amount to $1,422,495. Current liabilities were $759,100, it was reported. With the completion of the new shaft to deeper levels the mine will be in better condition to handle ore, and a considerable saving is anticipated. An output of 1,000,000 oz. of silver per month is expected by the management when improvements are completed.

✦ Offices of the Callahan Zinc-Lead Company and the Sunshine Consolidated, under the management of Frank Eichelberger, are now established in the Tabor Building, Wallace. Mr. Eichelberger will maintain his office there in the handling of these properties. Joseph T. Hall, formerly associated with Mr. Eichelberger as his assistant at the Sunshine, is in charge of the office, with Edith Strope as secretary.

✦ Charles W. Newton has retired as general manager of the Callahan Zinc-Lead Company and is succeeded by Frank Eichelberger, who took over the management under the terms of his option with the company.

✦ Operations at the Rainbow property in the Medimont district are satisfactory, according to George Austin, president and manager. The tunnel is being driven at the rate of about 100 ft. per month.

✦ Judge Hodges, of Moscow, has been assigned to hear the case of the Coeur d'Alene Mines Corporation in the suit involving questions of procedure at the annual meeting of the stockholders to which objection was made by A. C. Frost, a large stockholder, of Seattle. Judge Everett Hunt, of Coeur d'Alene, who was slated to hear the case, was disqualified by petition of some of the stockholders. Judge Hodges has not yet set the date for the hearing.

✦ The Silver Syndicate, Inc., with offices in Wallace, has filed a registration statement covering 1,000,000 shares of 10c. par value common stock to be offered at the market or a price to net the issuer 10c. per share. The net proceeds from the sale of the stock are to be applied to the development of the corporation's property in the Big Creek district. Walter Palmer, of Kellogg, is president and manager of the corporation, which owns a group of claims in the silver belt lying adjacent to the Sunshine mine on the north. More than 3,000 ft. of tunnel development work has already been accomplished, together with a shaft down more than 300 ft.

✦ The Idaho Mother Lode directors have levied an assessment of half a cent per share payable Sept. 29 to L. A. Montgomery, secretary-treasurer, at his office in Spokane, Wash. The delinquent stock sale is set for Oct. 19. Development operations at the Mother Lode, well-known Murray gold property, now call for the sinking of the main shaft an additional 500 ft. This was recommended by engineers and geologists who have studied the ground and are of the opinion the commercial orebodies will be found in depth.

✦ A group of young engineers have completed organization arrangements to form a society for the purpose of collecting and classifying a large display of minerals found in the Coeur d'Alenes and other mining districts in the State. The society will be known as the Geological Society of the Coeur d'Alenes. Meetings will be held in the Y.M.C.A. at Kellogg each second and fourth Wednesday of each month.

Kennecott Copper Corp.

✦ Kennecott Copper Corporation and subsidiaries for the six months ended June 30, 1936, after depreciation, Federal income taxes, minority interest, and other charges, just before depletion, report a profit of $9,097,891. No provision was made for Federal surtaxes on undistributed income. This compares with earnings of $3,418,097 in the first half of 1935.

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Rio Tinto Mines Producing

✦ It is announced that the staff of the Rio Tinto has returned to the mine, the Spanish rebels having occupied the area where the property is located. An official is quoted as saying: "The mines have not been interfered with. Workmen are at present clearing the mines and we are hoping that they will soon be in production again. The insurgents will probably ask for what they want when production begins, but we do not anticipate they will be unreasonable."

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Yugoslavia

Deeper Developments At Trepca's Stantrg Mine

✦ Development work on the 545-meter level of Trepca's Stantrg mine appears to be disclosing a most interesting condition. This is the deepest level, and for a long time it seemed that the zinc (which above had nearly equaled the lead in percentage) was disappearing. When a horizontal area of 7,191 square meters had been disclosed, the ore averaged 9.8 per cent lead, only 1.67 per cent zinc, and 4.49 oz. of silver per ton. Since then a further area of 215 square meters has been developed which averages 11.8 per cent zinc, 2.7 per cent lead, and 1.7 oz. of silver per ton. This may be taken to suggest that the zinc is decreasing with depth by separating itself from the main deposit and concentrating in fringe bodies. Deeper drilling has determined consistent lead content with increasing silver and very low percentages of zinc, ore similar to that of the 7,191 square meters mentioned on the 545-meter level. The net profit of Trepca Mines, Ltd., for the June quarter was £86,975 against £132,773 for the March quarter, the decrease being accounted for wholly by the suspension of activities for approximately a month by labor trouble. In August 53,865 metric tons of ore were milled, producing 5,848 tons of 78.46 per cent lead concentrate carrying 25.75 oz. of silver per ton, and 7,421 tons of 49.67 per cent zinc concentrates.

Australia

New Mills for Greater Gold Production

WILUNA STARTS smelting antimonial concentrates—Broken Hill reduces costs

✦ During July, Wiluna Gold Mines, Ltd., milled 49,464 tons, recovering 10,076 oz., which is the highest monthly tonnage to date. The working profit was £31,694. Working costs were 22s. 1d. a ton, including 3s. 9d. per ton for development redemption. The new smelting process for the treatment of the antimonial concentrate was placed in operation in September.

✦ Gold Horse Shoe (New), Ltd., is to install an additional Oliver filter to enable a larger tonnage from the Great Boulder No. 2 dump to be treated. In July 28,970 tons was handled, but the company hopes to raise the monthly capacity to 60,000 tons. The No. 2 dump contains 1,200,000 tons assaying 1 dwt.

✦ Ore reserves of South Kalgurli Consolidated, Ltd., at March 31, 1936, were 198,000 tons of blocked ore assaying 5.75 dwt. and 69,600 tons of probable ore of similar grade. During the year ended March 31, 1936, the company treated 120,371 tons, which is the highest to date, and made a profit of £41,240.

✦ Gold Mines of Kalgoorlie, Ltd., a subsidiary of Gold Exploration & Finance Company of Australia, Ltd., is to install a treatment plant at Kalgoorlie with a capacity of 10,000 tons monthly. Designs are now being prepared.

✦ Central Norseman Gold Corporation, at Norseman, W. A., is to increase its treatment plant from 100 to 200 tons daily. In July, 3,052 tons was treated for 1,075 oz.

✦ Paringa Mining & Exploration Company, Ltd., Kalgoorlie, has ore reserves of 141,045 tons valued at 40s. (Australian) per ton. A treatment plant with a capacity of 5,000 tons monthly is to be erected.

✦ Contracts have been let by Broken Hill Proprietary Company, Ltd., for a large-capacity bucket dredge to operate along the Wellington River, in New South Wales. The dredge will have 15-cu. ft. buckets and will weigh 2,600 tons.

✦ Costs at Broken Hill, N.S.W., have been so reduced that profits today are almost as great as in the high metal price period of 1926. This is the direct result of economies made during the depression.

✦ New Broken Hill Consolidated, Ltd., has been formed with a capital of £600,000 in 2,400,000 shares of 5s. each to develop a group of leases on the extreme southern end of the Broken Hill lode. The leases adjoin those of Zinc Corporation, Ltd. The zinc lode of Zinc Corporation, Ltd., has been proved by driving to continue into these leases and the main lead lode has been met in a deep diamond-drill hole 1,200 ft. south from the Zinc Corporation boundary at a depth of 1,900 ft. If further boring is satisfactory, a new shaft will be sunk. It is not expected that the lode will be met before 2,000 ft. of sinking has been done.

✦ Bismarck Range (Lucknow) Gold Exploration, N.L., operating the Birthday reef, at Lucknow, made a net profit of £33,547 for the fifteen months ended May 31, 1936, compared with £68,424 for the previous corresponding period. Dividends totaled £35,000, a reduction of £20,000. Values have been cut off by a fault and the continuance of the reef has not yet been found. An electrical geophysical survey by M. Milstein is to be made. The plant comprises a twelve-head battery with concentrating and cyaniding equipment.

✦ The Briseis mine, at Derby, Tasmania, was again flooded on Aug. 24 when the Ringarooma River broke through its banks. The operating company, Briseis Consolidated, N.L., had just completed dewatering and the preparation of the mine for large-scale sluicing following the previous flooding in 1929. The company was employing 140 men. Damage is estimated at £10,000.

✦ The Mount Lyell Mining & Railway Company, Tasmania, is now treating 14,000 tons weekly, which is a higher tonnage than that of any other nonferrous mine in Australia. About 75 per cent of the ore is being won from the West Lyell open cut. For the quarter ended June 30, 1936, the yield of copper was 3,043 tons.

✦ On the 120 level of the Loloma mine, Tavua, the average assay of the south drive for 145 ft. is 131 dwt. per ton by recent channel sampling. A treatment plant embodying roasting and cyanidation, and with a capacity of 100 tons per 24 hours, is now being erected on the property.

✦ The dredge of the Rimu Gold Dredging Company, Ltd., at Rimu, near Hokitika, N.Z., capsized on Aug. 18 and sank in 20 ft. of water. The plant has 12-cu.ft. buckets and a capacity of 3,000,000 cu. yd. annually. The ground is 40 ft. deep and carries 2.54 grains of gold per cubic yard. Salvage operations commenced immediately.

South Africa

Orange Free State May Contain Reef Extensions

DRILLING will determine merits of an unproved area—Minor earth movements at Simmer and Jack

✦ For some time the northwestern part of the Orange Free State, South Africa, has been receiving the attention of leading gold-mining interests, it being considered possible that the Witwatersrand reefs extend into that area. Now it is learned that large areas have been taken under option, and some drilling has been done. Union Corporation, Western Reefs, Anglo American Corporation, Central Mining, Consolidated Goldfields, and Anglo-Transvaal Consolidated Investment are among the strong companies said to be interested. Drilling done a year or two ago in the Odendaalsrust area, 60 miles southwest from the extreme far-western Witwatersrand activities, is said to have revealed reefs resembling those of the Witwatersrand, but with values which were not quite payable. It is understood that the companies regard the northwestern Free State area as a pure gamble, no gold ever having been produced there; but they believe the time has arrived for the ground to be tested. The possibility exists that values will be found.

✦ Simmer and Jack (Witwatersrand) reports that another earth movement occurred in the mine on Sept. 8, but it "caused only minor dislocation of underground work." It will be recalled that the company's output has been less than plant capacity for two months past as the result of caving in one of its shafts.

✦ The gold output of the Witwatersrand during August is stated by the Transvaal Chamber of Mines to have been 946,046 oz., and of outside districts 18,471 oz. This is 3,476 oz. less than in July, which was a new high record; but 35,186 oz. more than in August a year ago. The number of natives employed on the gold mines increased to 294,556, which is a high record for all time.

✦ Roan Antelope Copper Mines, Ltd., is to pay a dividend of 30 per cent (1s. 6d. per share; 6s. on the New York units) payable Oct. 15. Its annual report was issued on Oct. 2. The higher price of copper is expanding the company's earnings, as its cost, including depreciation and debenture interest, is between £23 and £24 per long ton. Its mine and plant are in readiness for an increase of production when demand for the metal warrants.

✦ West Witwatersrand Areas announces that all boreholes from E4 farther west have disclosed payable values, E5 on farm Blyvooruitzicht having intersected at a depth of 5,624 ft. an average of 8.9 dwt. over a width of 28 in., followed by 58 in. of quartzite, and then 4.5 dwt. over 12 in.; and E7, on farm Varkenslaagte, at a depth of 4,926 ft., 37.2 dwt. over a width of 14 in. The latter intersection is the farthest west so far reported. These reefs occur in some cases about 150 ft. above the green bar and in others just below. They are highly impregnated with carbon and apparently belong to the same horizon within the Main reef itself, but are to be known as the carbon leader. It is interesting that the green bar, which is a distinctive bed of green argillaceous quartzite, has been used as a marker in the eastern section of the Witwatersrand, where it occurs from 150 to 200 ft. below the Main reef.

✦ Libanon Gold Mining Company, Ltd., has been organized by West Witwatersrand Areas, in association with New Consolidated Gold Fields, Anglo American Corporation, and Central Mining & Investment Corporation, to acquire the benefit of a certain mining lease. The companies named will guarantee the subscription of 2,400,000 shares. This company will undertake the development of a part of the West Witwatersrand which has been proved by diamond drilling.

✦ Reitfontein (No. 11) Gold Mines has increased its capital from £650,000 to £1,100,000 and will raise about £450,000 of new working funds by the sale of 900,000 new shares.

✦ Rand Leases (Vogelstruisfontein) Gold Mining Company, which started production last April, made net profits of £23,750 in June and £24,520 in July. Results have been so satisfactory that it has been decided to expend approximately £600,000 on increased plant capacity. It is rumored that Anglo-Transvaal Consolidated and Johannesburg Consolidated Investment will supply the money by taking an issue of convertible debentures.

✦ In the Gold Coast district Ashanti Goldfields is making further sensationally rich developments. Such disclosures as 32.1 dwt. over a width of 12 ft., 43.3 dwt. over 17 ft., 12.5 dwt. over 64.5 ft., and 74.4 dwt. over 17.5 ft. are among others announced officially. The company milled 18,022 tons in August, recovered 17,227 oz. of gold, and made a profit of £78,121.

✦ Bibiani, always regarded by many as likely to become a second Ashanti Goldfields, has recently been opening up some good stretches of 13- to 30-dwt. ore. While extending its workings rapidly in search of rich shoots, it has made a commendable record of profits from the treatment of medium-grade ore. It milled 27,820 tons averaging 8.5 dwt. per ton in August, and it realized an estimated profit of £51,891 for the nine months ended with June. The margin of profit is rather low, but this may be accounted for by the heavy development and exploration work, 3,306 ft. being driven in the June quarter. Bibiani has completed the construction work on its pilot plant, bringing its capacity up to 10,000 tons per month.

✦ In Southern Rhodesia the results obtained by Bushtick, the very low-grade producer, have been slightly less satisfactory of late. It milled 10,200 tons in August for a recovery of 1,316 oz. of gold and a profit of £1,506.

✦ Rhodesia Minerals Concession (Northern Rhodesia) reports that at Chakwenga ten crosscuts have now proved the orebody to be 100 ft. in length, with the south end open. Over an average true width of 67 in. the ore averages 5 dwt. per ton, which includes 47 in. averaging 6.7 dwt.

✦ In Kenya the Kimingini Gold Mines milled 2,361 tons in August and recovered 720.19 oz. of fine gold. Tailings were down to 0.58 dwt.

✦ Kenya Consolidated Goldfields, working properties of considerable promise in Kenya, is to reduce its capital and then issue 800,000 new shares, which are to be underwritten by Fanti Consolidated Investment, of which Sir Edmund Davis is chairman. The object is to provide the company with sufficient capital for expansion.

✦ Rhodesia Broken Hill Development Company produced 1,740 long tons of zinc, 98 tons of vanadium concentrates, and 14 tons of fused vanadium in August.

✦ The gold and base-metal mines of Nigeria report that during the month of August they produced 93½ tons of tin concentrates, 420 oz. of gold from the Nigerian areas, and 55 oz. from the Sierra Leone areas.

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Proposed Development of Nowegian Pyrite Deposits

✦ Plans are being studied by the Norwegian Government for the development of the large Grong pyrite deposits in northern Norway. Engineers recently reported in Oslo on a plan to bring the ore via wire-rope haulage, railway, and ship to a port near a government-owned hydro-electric power plant. A large flotation plant is being considered to treat the ore, and annual output is estimated at 300,000 metric tons of pyrite concentrates, 25,000 tons of cupriferous ore, and 15,000 tons of zinc blende. The sulphur will be recovered from gases, and copper will be removed following the roasting. Iron will then be produced from the copper-free pyrites.

PERSONAL ITEMS

Arthur Notman sailed from New York in mid-September for a professional engagement in Africa.

Leroy A. Palmer, consulting engineer, has returned to San Francisco from a business trip to Montana, Idaho, and Oregon.

J. Onesime Gagnon, K. C., has become Minister of Mines and Fisheries for Quebec in the recently appointed Duplessis Cabinet.

J. C. Lederer, United Gilpin Corporation, Central City, Colo., is temporarily in Colorado Springs on business for his employers.

Frederick S. Cook has been appointed Pacific Coast manager for the Robert W. Hunt Company, engineers, with headquarters in San Francisco.

R. E. Barrett has resigned from Parkhill Gold Mines to take over the management of the Central Patricia Gold Mines, Ltd., Pickle Crow, Ontario.

J. P. Blaikie Webster, managing director of Mount Isa Mines, Ltd., and New Guinea Gold Fields, Ltd., arrived in Australia in August on a business visit.

Earl Herkenhoff, recently graduated from the New Mexico School of Mines, has been awarded a research fellowship in metallurgy at the University of Idaho.

S. G. Olmstead has joined the Penhoel-Menardi Engineering Company, of Los Angeles. Mr. Olmstead has designed many mills in the United States and Canada.

Ignacio C. Tanhueco, mining and petroleum engineer, is now on the staff of the milling department of the Itogon Mining Company, Inc., Baguio, Mountain Province, P. I.

R. W. Heindel, recently with the Idaho Maryland Mines Corporation, Grass Valley, Calif., is now with the Engineering Equipment & Supply Company, Manila, P. I.

William E. Stephens has resigned as experimental engineer for the Climax Molybdenum Company and is now employed by the Utah Copper Company at Bingham Canyon, Utah.

Charles W. Heyda, Jr., Manitowoc, Wis., is going to the Philippine Islands. His address after Oct. 1 will be care of Tambis Gold Dredging Company, Surigao, Mindanao, P. I.

James J. Jordan, lately with Dome Mines, Ltd., at South Porcupine, Ontario, Canada, is spending a vacation in California, his address being 2625 Baker St., San Francisco.

A. W. Newberry, mining engineer of Denver, Colo., was in New York early in September on his way to Canada, where he expects to spend about two months on professional business.

S. B. Goldberg has severed his connection with Sisco Gold Mines, Ltd., as assistant manager and has now become resident manager of all of the interests of the Que-On Mines, Ltd., in Quebec.

Percy H. O'Nians, of Tuolumne, Calif., is examining the old Summers mine and adjoining properties in the east belt of the Mother Lode, in the Tuolumne district, in behalf of London interests.

H. A. Guess, senior vice-president of the American Smelting & Refining Company, is visiting the Big Bell mine, at Cue, Western Australia. His company holds a controlling interest in that property.

Henry J. Gisler, who received his M.S. degree in metallurgy from the University of Utah last June, is employed as a metallurgist by the Virginia Mining Corporation, operating in Plumas County, Calif.

Dean A. W. Fahrenwald of the School of Mines at the University of Idaho has returned to the campus from a trip to the Island of Cyprus, where he did research work for the Cyprus Mines Corporation, an American concern.

C. H. Wilson, in charge of field operations for International Geophysics, has temporarily established headquarters at Carlsbad, New Mexico, in order to supervise field work in the Hobbs area in New Mexico and western Texas.

George C. Bateman, secretary of the Ontario Mining Association, addressed a luncheon meeting of the Mining Club of New York last month. He gave a survey of the gold mining industry of Canada, particularly Ontario and Quebec.

Dr. J. J. Jakosky, technical director of International Geophysics, spent a major part of August in the Mid-Continent area in connection with surface geophysical work and electrical well-logging operations being conducted by his company.

Charles E. Bersinger, recently in charge of the Oceanic mine of the Anglo-American Mining Corporation, at Cambria, Calif., has left that company to accept the position of mining boss with the Golden Queen Mining Company, at Mojave, Calif.

Humphrey W. Chadbourne and Scott Turner have been in Canada, **J. C. Brennon** has been in Costa Rica and Colombia, **J. S. Wroth** is in Nevada, **Murray Crossette** is in Mexico, and **S. Ricker** is in Quebec. All are representing International Mining Corporation.

W. L. Bell, manager of the Marietta Mining & Milling Company, Virginia City, Madison County, Mont., has been made consulting engineer of the Butte Highlands Mining Company, in the Highlands Mountains, south of Butte. A new cyanide plant was recently constructed.

J. C. Honsberger, who had been with Noranda Mines, Ltd., for the last six years as stope engineer, and more recently as mine shift boss, has resigned to take up his new duties as field manager of the Hennessy Exploration Company, Ltd., with offices in Haileybury, Ontario.

John K. MacGowan, who was for 25 years associated with Guggenheim Brothers, for five years as partner in that firm, has been elected chairman of the executive committee of the Central Foundry Company, with offices in the Graybar Building, 420 Lexington Ave., New York City.

Sydney A. Mewhirter has been for the past six months in Colombia, South America, where he is doing professional work for Cia. de Cementos, Portland Diamante, and other mines. He will return, by plane, the latter part of October, and may be addressed at 943 West King's Highway, San Antonio, Tex.

J. R. Van Pelt, assistant director in charge of the technical division of the Museum of Science and Industry, Chicago, has been elected president of the Western Society of Engineers for the second time in three years.

Philip D. Wilson, vice-president of Pardners Mines Corporation, 405 Lexington Ave., New York City, sailed on Sept. 13 for England on business connected with Siamese Tin Mines, Ltd., in which the company is interested. His London address will be British American Mines, Ltd., 62 London Wall, E.C. 2, London.

E. E. Campbell is president and **S. Power Warren** vice-president of the recently organized Mining Research Corporation, Toronto, Canada. **Dr. C. V. Corless, Wilbert G. McBride,** and **Hans T. F. Lundberg** are directors. The corporation offers specialized consulting service to the mining and metallurgical industries.

Henry Ross Taylor, consulting metallurgist of Vancouver, B. C., Canada, is manager of the Norcal Mining Company at Sawyer's Bar, Calif. The property is undergoing considerable development and diamond drill work is planned for the near future. The 60-ton mill is operating at capacity. Mr. Taylor expects to return to Vancouver in the fall, where his address is 6625 Cypress St.

Rensselaer H. Toll, consulting mining engineer, of Los Angeles, is building a 30-ton flotation mill for the new Skyline mine, in Pine Tree Canyon, 14 miles north of Mojave, Calif. The mine is situated about 5 miles west of the Los Angeles aqueduct and a quarter of a mile higher, but the mill is close to the aqueduct, from which it will secure its water. Operations at the mill started on Oct. 1.

Matthew Van Siclen, consulting engineer and formerly chief mining engineer of the United States Bureau of Mines, has returned from examining mines in New Mexico and Arizona to his Washington, D. C., headquarters. While on his trip he spoke before the Tri-State Section of the A.I.M.E. at Picher, Okla., on his recent work in Asia Minor as consulting mining engineer to the Turkish Government.

Albert W. Hahn, consulting metallurgist, has changed his office address from Dooly Block, Salt Lake City, to Balfour Building, San Francisco, where he will continue to specialize on nonferrous metallurgical investigations and processes. He has been elected president of the Metalead Products Corporation, which will manufacture flaked metallic lead, a new product for coating metal, concrete, and wood surfaces.

Wilbur H. Grant, consulting engineer, with offices in the Hobart Building, San Francisco, has been in Montana on professional business.

H. R. Plate, general manager, has severed his connection with Spring Hill Gold Mines, Inc., at Grass Valley, Calif., and is now in San Francisco to engage in consulting work. He is succeeded by **Don Carlos Billick,** formerly mill superintendent.

A. A. Hoffman, mining engineer, of San Francisco, has been appointed California manager of the American Potash & Chemical Corporation, with headquarters at Trona, Calif.

John M. Lovejoy, president of the American Institute of Mining and Metallurgical Engineers, accompanied by **A. B. Parsons,** secretary of the organization, visited Salt Lake City Sept. 14 on their annual Western tour. Mr. Lovejoy and Mr. Parsons were entertained by the Utah chapter of the A.I.M.E.

W. Spencer Reid, superintendent of the American Smelting & Refining Company's lead smelter at Murray, Idaho, for fifteen years, has been transferred to the company's plant at Selby, Calif.

Henry B. Van Sinderen, New York and London capitalist, has been named president of the Callahan Zinc-Lead Company, by the new board of directors, succeeding **Donald A. Callahan,** of Wallace, Idaho. Members of the new board of directors are **Dr. Max T. Smith,** Wallace, vice-president, only holdover board member; **Frank Eichelberger,** Spokane, general manager; **Joseph T. Hall,** Wallace, secretary-treasurer; **Hamilton Baker,** Boston; **Prentice D. Ash,** New York; **Charles Finucane,** Spokane, and **W. M. Yeaman,** Yakima.

John M. Forbes has been engaged by Pandora-Cadillac Gold Mines, Ltd., as consulting engineer and has taken over the direction of work at the company's property, in northern Quebec. A new electric mining plant is being installed.

H. T. Dickinson, for some years consulting engineer to De Beers Consolidated Mines, has been made a member of the board of directors of that company.

Sir Albert Bennett has become a member of the board of the Rhodesian Selection Trust.

H. E. Haultain, professor of mining engineering at the University of Toronto, who recently made a visit to South Africa, is returning to the United States.

H. E. Walker has been elected president and general manager of Paymaster Consolidated Mines, Ltd., of South Porcupine, Ontario. **A. E. Fuller** is vice-president; **E. L. O'Reilly,** secretary and treasurer; and **A. W. Hodgetts,** assis- and treasurer.

Dr. E. P. Mathewson, of the University of Arizona, at Tucson, formerly manager of the Washoe smelter of the Anaconda Copper Mining Company, and former manager of British American Nickel Company, recently paid a visit to properties in Montana.

L. F. Padisson has been examining a large property in British Columbia for the United States Smelting & Refining Company.

Otto Ellerman, for many years correspondent for *Engineering and Mining Journal* in the Black Hills of South Dakota, and formerly State Mine Inspector of that commonwealth, recently designed a 100-ton cyanide plant for the Chiquita Mining Company, Ltd., of Good Springs, Nev. Milling was begun the last part of July.

E. A. Strout, general manager of the San Francisco Mines of Mexico, sailed for Europe on the "Queen Mary" on Sept. 23. He expects to return about Oct. 12.

John B. De Mille, of Montreal, consulting geologist, writes from Dyke Lake, Labrador, that several geological parties have been engaged in reconnaissance mapping in Labrador and that he has been going over the showings opened up which may have economic possibilities.

OBITUARY

Bruce Clinton Yates, 66, general manager of Homestake Mining Company, Lead, S. D., died on Aug. 10 after collapsing at his office. Mr. Yates had been in service of Homestake for many years and had been general manager

BRUCE CLINTON YATES

since 1918. After several years with the Burlington Railroad and later with the Government, Mr. Yates formed a partnership in civil engineering in the Black Hills which continued until his connection with Homestake Mining Company.

Thomas J. Clark, mining man, prominent in Goldfield and Tonopah developments, died on Aug. 2 at Tonopah.

William Wolsey Raymond, mine superintendent of the Black Forest mine of the Missouri-Monarch Consolidated Innes Company, died recently in Los Angeles, Calif., at the age of 49.

Frederick John Siebert, retired mining engineer, who went from White Plains, N. Y., to Palo Alto, Calif., a few weeks ago, died in Palo Alto on Sept. 12, aged 62.

Richard Hosken died recently in Johannesburg at the age of 80. Mr. Hosken had been identified with the mining industries of the Rand since 1897. He took an active part in rehabilitation activities during and after the South African War of 1899 and the World War.

J. H. Hyde, of the staff of the Shabanie mine, in Southern Rhodesia, for the past eight years, died recently from the results of a severe leg injury.

William Skinner, formerly active in mining communities of both the Rhodesias, died last August at Bulawayo.

Harold G. Mitchell, mining engineer, formerly of Salt Lake City, died in Boise, Idaho, on Sept. 1. Mr. Mitchell was 35 years of age.

A. C. H. Gerhardi, prominently identified with the mining industries of South Africa, a distinguished soldier in the World War in the Canadian forces, died on Johannesburg on July 27, at the age of 50.

Dean Henry Landes, for forty-one years professor of geology at the University of Washington and State Geologist from 1901 to 1920, died at his home in Seattle on Aug. 23, at the age of 68.

William M. Lennox, long prominent in the mining industries of Colorado, died on Aug. 13 at Colorado Springs, at the age of 85.

A. W. Sutherland, retired mining engineer of Fresno, Calif., died recently in San Francisco, in his 83d year.

George Henry Dern, mining engineer, mine manager, metallurgist, elected Governor of Utah in 1924, and Secretary of War in the Cabinet of President Franklin D. Roosevelt, died in Washington, D. C., on Aug. 27. Mr. Dern was born Sept. 8, 1872, on a farm in Dodge County, Neb. He attended the public schools, Fremont Normal College and University of Nebraska. He left the University in 1894 to go to Utah, where his father had become interested in mining. Starting as bookkeeper in the office of the Mercur Gold Mining & Milling Company, he advanced to the position of treasurer. With the formation of the Consolidated Mercur Gold Mines Company he was appointed in 1902 general manager of the corporation, a position he held until the mines were closed in 1913. He was general manager of the Tintic Milling Company from 1915 to 1919. He did pioneer work in certain improved metallurgical processes, notably vacuum slime filtration and the Holt-Dern system of ore treatment. He became a member and officer of the American Institute of Mining and Metallurgical Engineers and of the Utah Chapter American Mining Congress. From 1918 his time was largely occupied by public duties and his mining interests were relegated to the background. He served two terms as Governor of Utah. A biographical record of Mr. Dern's earlier life and achievements was presented in *Engineering and Mining Journal* of Jan. 24, 1925.

NEW BOOKS

Fundamentals of Engineering

HANDBOOK OF ENGINEERING FUNDAMENTALS. *O. W. Eshbach, editor-in-chief, and 40 contributors. John Wiley & Sons, Inc., New York. Pp. 1081, illustrated. Price $5.*

So much emphasis is being laid today on the importance of fundamentals that one may confidently expect to find it reflected in a sustained demand for a volume such as this that will be pleasing to both its publishers and those who have labored to produce it. Engineering handbooks there are a-plenty, each major division of the profession boasting its own, and such volumes normally devote some space to general fundamental information in addition to a vast deal of facts and figures that concern primarily the respective divisions that the handbooks are intended to serve. The new volume, however, is unique in embracing within its covers the fundamental data required by engineers of all classifications. It is designed to present a complete summary of the facts pertaining to the fundamental theory underlying engineering practice. This is shown by the thirteen sections of its table of contents, which are headed, respectively:

(1) Mathematical and Physical Tables (168 pages). (2) Mathematics (128 pages). (3) Physical Units and Standards (45 pages). (4) Theoretical Mechanics (47 pages). (5) Mechanics of Materials (94 pages). (6) Mechanics of Fluids (54 pages). (7) Engineering Thermodynamics (96 pages). (8) Electricity and Magnetism (69 pages). (9) Radiation and Light; Acoustics, Meteorology (69 pages). (10) Chemistry (40 pages). (11) Metallic Materials (110 pages). (12) Non-metallic Materials (84 pages). (13) Contracts (28 pages).

The type used is large enough to be clear and readable. Sentences are complete, as in any textbook. In the presentation of tables, which include new and revised ones of the American Handbook series, attention has been given to arrangement, typography, and general convenience. It is safe to say that any engineer will want to possess this book, once he has seen it.

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Facts and Figures

MINERALS YEARBOOK, 1936. *Compiled for the United States Bureau of Mines by O. E. Kiessling and H. H. Hughes. Pp. 1089. Illustrations 154. For sale by Superintendent of Documents, Government Printing Office, Washington, D. C. Price $2.*

Annual survey of economic developments and trends in the mining industry of the United States for the year 1935. Of the four subdivisions of the book, one deals with a general review and statistical summary, the second with individual metals, the third with nonmetals, and the fourth with mine safety. Thirty-four world charts portray graphically the world production and consumption of mineral commodities for 1932.

Engineering Education

THE PROFESSIONAL ENGINEER. *By Esther L. Brown, department of statistics, Russell Sage Foundation. Published by the Foundation, New York. Pp. 86. Price 75c.*

This is an excellent brief summary of the growth and development of engineering education in the United States and the current status and trend of that branch of education. It traces the history of engineering organizations and their influence, together with that of engineering colleges, on the professional status of engineers. Data are also given on numbers of engineers and demand for their services, together with earnings of practicing and educational groups. The summary is authoritative, deriving its basic data from studies by the Society for the Promotion of Engineering Education and other engineering bodies.

Old Man Corrosion

CORROSION RESISTANCE OF METALS AND ALLOYS. *By Robert J. McKay and Robert Worthington. Published by Reinhold Publishing Company, New York. Pp. 455 plus 38 of index. Price $7.*

This is a book that should be added to every mining engineer's bookshelf of materials of construction. It is one of the best volumes dealing with the corrosion of metals that we have ever had the pleasure of reading. The authors have made a long study of corrosion and have been in the fortunate position for many years of having had first-hand experience with a vast number of corrosion problems in industry.

The engineer who has the problem of making a machine or structure last as long as possible in corrosive conditions, should have a general knowledge of how corrosion works. The first hundred pages have been devoted to general and theoretical phases of the subject. Here the authors discuss factors dealing with the rate of corrosion, such as movement, electrolytic effect, solid films, and temperature. They also cover forms of corrosion, corrosives, and corrosion properties of metals.

The other part of the volume deals with the corrosion behavior of specific metal and alloy groups. A chapter is devoted to each group. The general corrosion resistance of the base metal and its alloys is discussed, followed by the effect of a dozen or more of the most commonly encountered chemicals and gases, and high temperatures. Many references are given throughout for the benefit of the engineer who wants to secure additional information on any particular point under discussion. And to each chapter is appended a complete bibliography.

The engineer interested in the effects of such corrosives as mine waters, sulphur gas, and high temperatures will find much valuable material throughout the volume. For example, in the chapter on silicon-iron, data are given showing the results of tests made where specimens of this alloy were immersed 98 to 135 days in flowing acid mine water at room temperature. In another chapter results of exposure of nickel specimens in flowing acid mine water at atmospheric temperature are tabulated. But these are only two of the many references to mine waters. And there are just as many references to the action of sulphur and other corroding media encountered in the mining industry. JAMES A. LEE.

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PUBLICATIONS RECEIVED

Transvaal Chamber of Mines. Forty-sixth Annual Report, 1935. Johannesburg, South Africa, Pp. 186. Accompanying this is an 11-page pamphlet of notes regarding the history and activities of the Chamber and its subsidiaries.

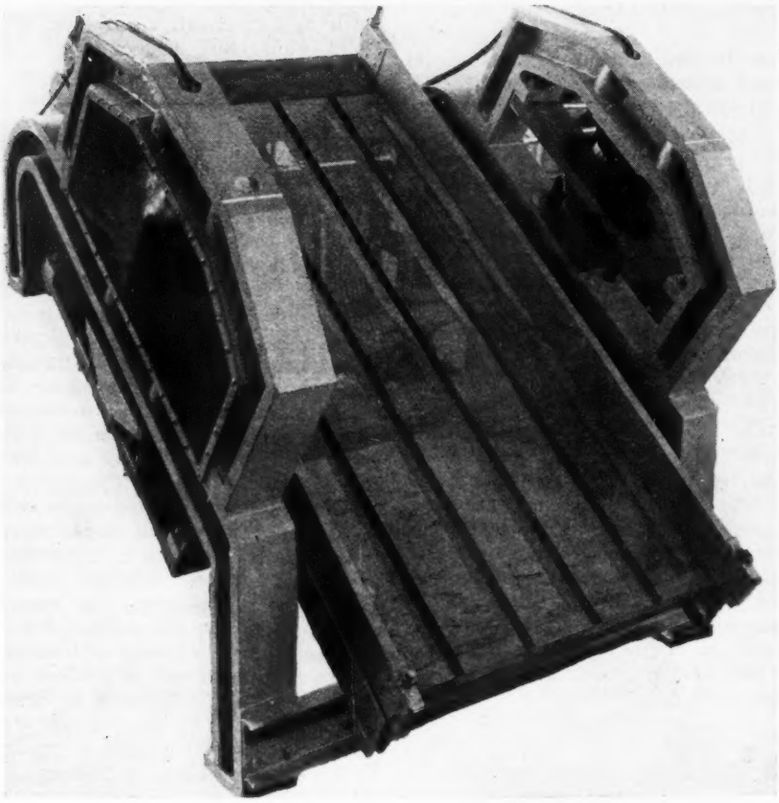
Cost of Distribution of Electricity. Power Series No. 3, National Power Survey, Federal Power Commission, Washington, D.C. Pp. 148.

Arizona Metal Production. By Morris J. Elsing and Robert E. S. Heineman. Bulletin 140, Economic Series No. 19, Arizona Bureau of Mines, Tucson, Ariz. Pp. 112.

Placer Mining in Nevada. By W. O. Vanderburg. Bulletin of Nevada State Bureau of Mines and Mackay School of Mines, Reno, Nev. Pp. 180.

Musoma District, Tanganyika Territory, Geology of the South and Southeastern Regions of. By G. M. Stockley. A preliminary survey of the Ikoma and Kilimafeza regions and the Serengeti game reserve. Short Paper No. 13, Geological Division, Department of Lands and Mines, Dar es Salaam, Tanganyika Territory, East Africa. Pp. 48, Price 4s.

EQUIPMENT NEWS



ELECTRIC VIBRATING SCREENS AND FEEDERS

Four years of experimentation and operation have brought the development of electric vibrating screens, feeders, and conveyors to a high state of efficiency at the Magna plant of the Utah Copper Company. The success of this new equipment has been further demonstrated in other plants in the United States, Canada, and Chile.

A few of the results obtained are: Higher screen efficiency, lower power consumption, and the replacement of pan feeders with electric vibrating feeders. Greater intensity of vibration at a minimum power consumption has reduced the circulation tonnage within the roll grinding circuit. Tonnage rates can be regulated to any capacity by means of a simple voltage changer, so that the tonnage rate will remain uniform. The vibrating feeders are also showing a high degree of efficiency in giving an even and steady flow of ore to the screens.

Lower power consumption of both screens and feeders results from the development of a new electro-magnetic vibratory motor especially designed for a uniform and heavy-duty machine. This same type of vibrator is also successfully applied to much smaller units.

The new type of apparatus is said to apply the electro-magnetic forces equally in both directions, so as to produce a lower power-actuated reciprocating movement, similar to that of a steam-engine piston, except that the forces are acting each way from a center of rest.

A wood vibratory member has been applied because it is not necessary to store any considerable amount of energy in a stiff spring or steel bar to furnish power for the return stroke. Furthermore, this wood member does not become fatigued or break under a continuous vibration such as would be true of steel or other metals.

The principal new features of the vibrating equipment are:

1. All the harmonic forces are inherently cut in half because the vibratory member moves both ways from a central position, rather than all in one direction from the unstrained position. The required magnetic forces are therefore said to be cut in half and with much less mechanical stress. There will be less chance of damage to the armatures striking the magnet cores.

2. The great intensity of vibration is said to be accomplished by superimposing a resilient wood member between the vibratory motor and the vibrated member. This amplifies the vibrations in the screen or feeder so that the vibrations in the vibratory member can be held at a minimum, thus reducing maintenance costs, with a corresponding increase in the life of the vibratory motor.

3. This arrangement is said to insure lower power consumption per ton of material handled. By reason of active vibration over the entire screen-cloth area, screens show greater capacity per square foot.

4. The vibrators operate on any alternating current, voltage, or frequency without any form of rotating apparatus. They require the well-known and dependable copper oxide rectifying unit to split the alternating current cycles into halves, thus delivering each successive half-wave or half-cycle to opposite magnetizing coils and giving a reciprocating motion to the screen or feeder.

5. Density of vibration can be varied over a wide range by the operator by simply applying the proper voltage with a suitable voltage-control apparatus.

6. This apparatus, operating on a standard alternating current, can be electrically interlocked with other electrical machines, offering more economical operation and mutual protection to both.

7. Vibratory means can be made to any size and the coils wound for any voltage and frequency; no shaftings, belts, cams, or motor-generator sets must be maintained; the free area above the screens allows easy accessibility for quick change of screen cloths; screens can be made to accommodate one, two, or three screen cloths.

Arrangements have been completed with the Allis-Chalmers Manufacturing Company of Milwaukee, Wis., by the Utah Electric Vibrator Company, of Magna, Utah, of which E. W. Engelmann is president, to manufacture and sell all machines using the company's electric vibratory patents.

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Electrodeposition of Tungsten

The Tungsten Electrodeposit Corporation, Barr Building, Washington, D. C., announces a process by which tungsten is electrodeposited in a homogeneous combination with one or more metals through the same electrolytic solution. Various combinations of useful metals are said to be used if desired, such as tungsten-nickel, tungsten-nickel-molybdenum, and quaternary combinations such as tungsten-nickel-cobalt-iron.

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Eye Protection

American Optical Company, of Southbridge, Mass., announces another addition to its line of eye-protection equipment—the F-3105 Ful-Vue goggle. This equipment,

according to the manufacturer, has all the comfort and safety features of the regular Ful-Vue goggle—high-up end-pieces, self-adjusting nose pads, 6-curve super armorplate lenses, and side shields that provide extra protection against particles striking from any direction. The wire-mesh screens are said to be non-corrosive and easily cleaned. In these screens the mesh is considered sufficiently fine to prevent the passage of flying particles but does not hinder air circulation. The metal frame is also non-corrosive and is said to be available in a wide variety of bridge sizes.

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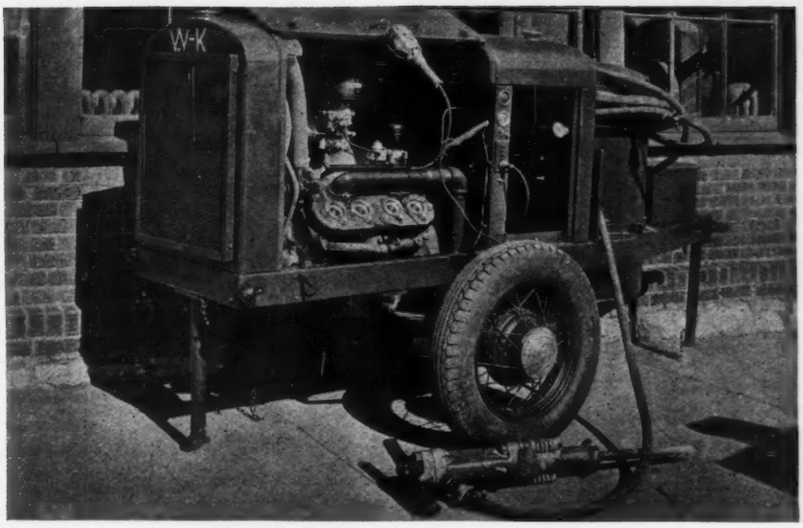
Portable Sample Catcher

The new Wilfley sample catcher announced by Mine & Smelter Supply Company, of Denver, was designed to meet the requirements of the mine sampler and engineer. It is a funnel-like device made of heavy, durable canvas with a steel frame at the top. The inside is said to be smooth

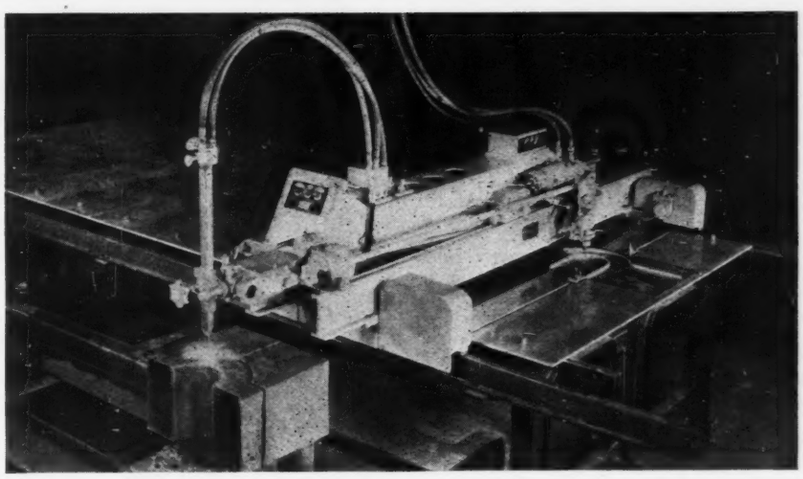
and as nearly seamless and cornerless as possible. Any size ore sack can be used with the catcher by folding the mouth of the ore sack around the funnel ring. The ore sack is said to be held securely by a tapered ring and can be released only as the operator sees fit to do so. This complete unit weighs only 2½ lb. It is said to collapse to a thin, flat article which can be carried in a pack sack or strapped to the side of a suitcase. Transfer of samples from one receptacle to another is not necessary. Therefore, there is no loss from spilling, as all fines are secured in the sample bag.

The adjustable handle permits the operator to place the mouth of the funnel at many angles or against a sloping wall close to the point of sampling. The feature of a neck strap permits one man to do the sampling, and also permits the sampler to use both hands if necessary.



PORTABLE AIR COMPRESSOR

The Wenzel-Kenney Machinery Company, of 229-231 Southwest Boulevard, Kansas City, Mo., announces the manufacture of light, portable air compressors said to be convenient and practical for mine work. Two sizes of compressors are made, both utilizing the Ford V-8 type engine. In one machine one bank of the V-8 is used for power with the other bank making air by using the manufacturer's patented W-K air head. In the large machine two V-8 engines are used; one for power and the other for air. The manufacturers point out that Ford V-8 parts are used for repairs, and operation of the unit is economical. Stopers, jackhammers, and other miners pneumatic tools are said to have been used with this machine. The compressor unit shown in the photograph is equipped with electric lights, electric starter, oil gage, ampere gage, and heat indicator, all at no extra cost. A tachometer may be furnished at a small extra cost.



SHAPE-CUTTING MACHINE

Introduction of the new Oxweld Type CM-12 shape-cutting machine by the Linde Air Products Company makes available to the metal-working industries a machine said to give the accuracy and range of work demand of the flame-cutting processes. The flexibility of this machine is said to allow almost limitless possibilities for its use. It is said to be more powerful and has a greater cutting capacity than any other machine in its class. Any shape, from the simplest to the most complicated, can be accurately produced, either automatically with templets or guided by hand. The immediate transfer of motion from one end of the machine to the other is a factor in assuring precision in all cutting operations. In addition to cutting shapes of all description, the machine will cut straight lines automatically in any direction and at any bevel. Cuts as long as 144 in. are possible and straight line cuts can be made at any desired angle in the horizontal plane. A special circle cutting attachment is also provided, thus enabling the automatic production of circles from 2 to 24 in. in radius. Another feature is that of multiple cutting. The apparatus is designed to carry from two to five blowpipes which can perform multiple cutting operations under all the conditions possible with a single blowpipe. The features of design and construction

which make possible the accomplishments of this new shape-cutting machine typify the trend in modern machine development.

Complete inclosure of the vital working parts is said to afford proper lubrication and freedom from maintenance. The motor, rated at ½ hp., produces a driving force reliable under all conditions. The speed range of the CM-12 is from 1½ to 75 in. per min. All important controls have been duplicated so that operation is possible from either blowpipe or tracing position. The blowpipes used have been constructed to give greater flame stability and increased economies in cutting. Material up to 12 in. in thickness are said to be easily handled; for heavier cuts a special blowpipe is available.

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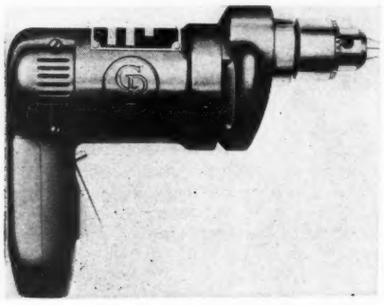
Small Drilling Tool

A small drilling tool of pistol-like proportions has been announced by the Chicago Pneumatic Tool Company of 6 East 44th St., New York City. The machine has an over-all length of 7 1/16 in. and weighs 2 lb. and 10 oz. It is said to drill



3/16-in holes in metal or wood and has a loaded speed of 2,100 r.p.m. and a spindle offset of ¾ in. Standard equipment consists of three-jaw smooth body chuck and key and 10 ft. of No. 3 conductor cable and plug, and drills for 32 volts and 250 volts can be furnished on special order. The machines are available in three sizes.

●

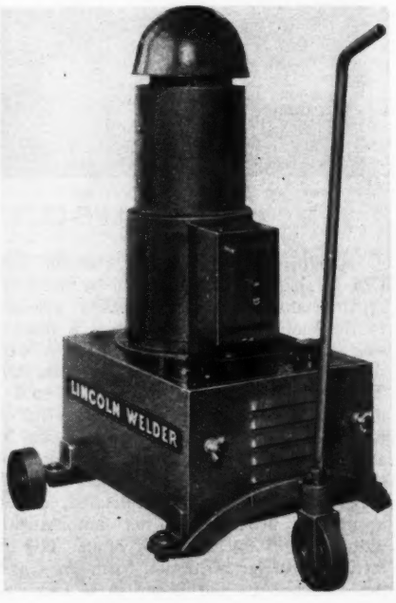
Stationary Compressor

The Sullivan Machinery Company, Michigan City, Ind., announces a new stationary heavy-duty air and gas compressor of the single-stage, single-cylinder, double-acting horizontal type, built in sizes from 10 to 50 hp. and for pressures from 5 to 150 lb. Advantages claimed are long life, low power cost, and fully automatic operation. Features stressed are Timken double-row main bearings, replaceable cylinder liner and crosshead guide, tinned piston and crosshead, and streamline long-life valves.

●

Welding Machine

A new motor-driven, single-operator type arc welder for general fabrication and repair work has been developed by the Lincoln Electric Company, Cleveland, Ohio. This machine, designated as the "SA-150," with a rated current range of 45 to 200 amp., is intended for a wide variety of applications. These include sheet-metal work, hard-facing of many types, pipe-welding, cast-iron repair, fit-up and auxiliary work in shops where heavy welding predominates, and regular production welding involving steel, alloy, and non-ferrous plates and shapes. It can be used with either bare or shielded arc-type electrodes. It is claimed the utility of this new welder is broadened by the fact that it has no inflammable materials, such as cotton, fiber, wood or bakelite at the proper joints. A class B insulation is used, which is said to insure against burnouts, permitting sustained overloads without injurious effect. It is said that some shops are using it with electrodes as heavy as ¼ inch.



●

Air Circuit Breaker

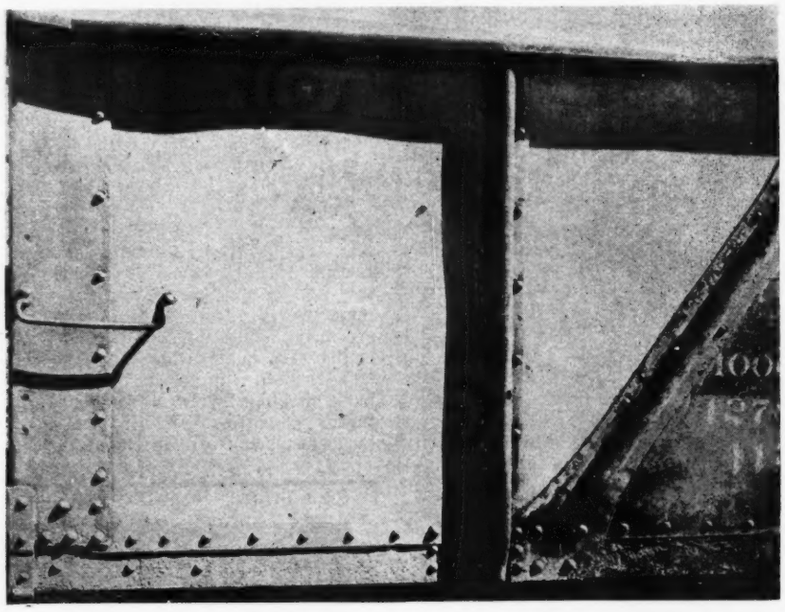
A new air circuit breaker, Type AE-1, adapted to industrial and station auxiliary service, or for any heavy duty where many opening and closing operations are required, has been announced by the General Electric Company. The breakers have a 20,000-amp. interrupting rating and are for operation on circuits of 250 volts d.c. and 600 volts a.c. at 15 to 600 amp. The standard arrangement is an inclosed breaker with pull box for mounting on a wall or behind a switchboard panel; without pull box, for mounting on the front of the switchboard. Main contacts are silver-to-silver; arcing contacts are of special alloy. Double- and triple-pole units are available. A selective overload feature differentiates between overload and short circuits, time delay being provided up to six to ten times calibration setting and instantaneous above that. The mechanism is electrically operated, trip-free, and latched-in with a solenoid suitable for either a.c. or d.c., depending on rating.

The unit is said to be completely inclosed, with the base included within the case. Approximate dimensions with pull box are 19 in. wide, 21 in. high, and 21 in. deep.

COPPER COATING

American Coppercote, Inc., of 480 Lexington Ave., has announced a new preservation coating for wood, metal, and other surfaces, under the trade name of "Coppercote." The product, which may be applied with a brush, by spraying, or by dipping, deposits a pure metallic copper of extreme fineness and of irregular flaky structure on whatever object is treated. In this process the copper particles combine and adhere closely to the base while the vehicle is said to rise and form a second protective film. The phenomenon is said to permit the use of various colors in the vehicle. The material is a quick-drying and quick-hardening coating which attains a flint-like hardness, and is said to be unaffected by extremes of temperature. When applied on wood as on metal it is said to form an air-tight, water-proof, fire-resistant coating of pure metallic copper. It can be applied to rusty metal and the destructive corrosive action of the rust is halted.

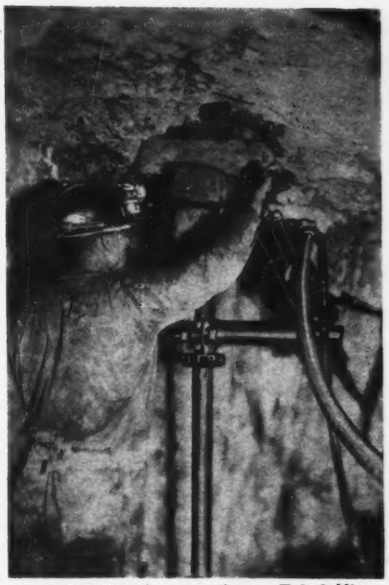
A SMALL PORTION of this rusted gondola standing in a railroad yard was selected for testing the corrosion resistance of the copper coating, and this photograph was taken fifteen months after application. The unpainted portion may be seen in the lower right



Motor-Operated Timer

Walser Automatic Timer Company, Graybar Building, New York City, N. Y., announces the Jewel No. 11, a new model of repeating-interval timers. It is said to be a compact unit which may be adapted to any time sequence of open and closed circuits over time cycles of seconds, minutes, or hours. Two or more adjustable cams, mounted on a drum, are rotated by the self-starting motor through reduction gears to obtain the time cycle required. The frequency of contact is a product of the speed per revolution and the number of cams on the drum. The cams are said to be easily adjusted to obtain varying ratios of closed and open circuits within the fixed limit of the time cycle. This range varies with the number of cams on the drum but can be provided for 95 per cent on and 5 per cent off, or 95 per cent off and 5 per cent on.

The entire unit is inclosed in a metal housing, with cover, from which it may be removed when required. A threaded opening with insulating bushing is provided on one side of the housing to admit lead-in wires. Bushing according to the manufacturer, may be removed for conduit piping connection.



THE MINER is operating a T-9 drifter manufactured by the Sullivan Machinery Company. The makers claim the improved valve design and ability to maintain a strong powerful rotation afford greater drilling speed.

BULLETINS

Speed Reducers. The Falk Corp., Milwaukee, Wis. Bulletin 1100, on parallel shaft speed reducers, capacities 1 to 1,000 hp.; with 45 different standard ratios. Pp. 56. Bulletin 2100, right-angle speed reducers. Pp. 60.

Air Circuit Breakers. Roller-Smith Co., 233 Broadway, New York. Catalog 5. Pp. 13. Portable Electrical Measuring Instruments Catalog 123. Pp. 19. Graphic Instruments, Catalog 830. Pp. 4. Precision Balances Catalog 240. Pp. 8.

Bolts, Nuts, Screws, and Washers. The H. M. Harper Co., 2620 Fletcher St., Chicago, Ill. Catalog in color of 2,200 stocked items made of brass, bronze, Everdur, Monel metal, and stainless steel.

Compressors. Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin L-611-B-12, on single horizontal three-stage steam and motor-driven compressors; L-611-B11, single-tandem horizontal two-stage steam- and motor-driven compressor; L-620-B16 vertical two-stage air-cooled compressor. Pp. 8 each.

Diesel Engines. Worthington Pump & Machinery Corp., Harrison, N. J. Folder S-500-B22, on vertical four-cycle direct-injection type BB engine. Pp. 4.

Starting Switches. General Electric Co., Schenectady, N. Y. Folder GEA-1522 C, on manual motor-starting switches, full-voltage type, a.c. and d.c. Pp. 4.

Rake Classifiers. Denver Flotation & Cyanide Co., Continental Oil Bldg., Denver, Colo. Bulletin CL 6, on duplex and simplex rake-type classifiers. Pp. 7.

Portable Scraper Conveyor. Jeffrey Manufacturing Co., Columbus, Ohio. Bulletin 623, describing features of Type 219B portable conveyor. Pp. 3.

Pumps. Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin W-321-B4B, on Monobloc centrifugal pumps, Type DE; W-350-B1, on centrifugal acid pumps, Type CG, capacities to 130 g.p.m., heads to 70 ft. W-310-B5 on pressed-steel frame-mounted centrifugal pump, Type CF; W-102-B1A, on horizontal duplex piston pumps for handling liquids at pressures up to 200 lb. per square inch. Type TB; L-711-B2, on horizontal dry vacuum pumps, single and two stage, steam or belt driven; W-319-B1, on centrifugal boiler feed pumps; W-321-B9, on Monobloc centrifugal pumps for heads up to 250 ft.; W-101-B6, on horizontal duplex steam pump and receiver sets Type VC; W-450-R25, on vertical turbine pumps for mine sinker service. Pp. 4 each.

Motors. The Lincoln Electric Co., Cleveland, Ohio, motor folder. No. 206 on totally inclosed fan-cooled motors. Pp. 3.

Induction Motors. General Electric Co., Schenectady, N. Y. GEA-1974 on fractional-horsepower general-purpose squirrel-cage induction-motors, Type K. Pp. 4.

Dust Respirators. Pulmosan Safety Equipment Co., 176 Johnson St., Brooklyn, N. Y. Folder on "M" type respirators for severe industrial dust conditions.

Pumps. Byron Jackson Co., Berkeley, Calif. Bulletin 360 B. Single- or two-stage units, consisting of Bilton pump and motor without flexible coupling or baseplate. Pp. 11.

Heat-Resisting Steels. Hadfields, Ltd., Sheffield, England. Bulletin 390, illustrating special types of heat-resisting steel for industrial use. Pp. 23.

Electric Control Apparatus. Allen-Bradley Co., Milwaukee, Wis. An index of 63 bulletins describing electrical control equipment. Pp. 7.

Transformers. Wagner Electric Corp., St. Louis, Mo. Bulletin 180 on distribution transformers for all commercial frequencies and voltages in sizes 1.5 to 500 kva. Pp. 102. Bulletin 181, on power transformers discusses construction features and installations of all types of single- and three-phase transformers of ratings 501 kva. and above. Pp. 70.

Photo-Micrographic Equipment. Bausch & Lomb Optical Company, Rochester, N. Y. Catalog E-21, illustrating photographic and photo-micrographic apparatus. Pp. 35.

Bearings for Cranes. SKF Industries, Inc., Philadelphia, Pa. Bulletin 236-38-5-36, illustrating various types of mountings for cranes. Pp. 32.

Automatic Scales. Richardson Scale Co., Clifton, N. J. Bulletin 4236 describing automatic weighter for crushed, granular, and powdered materials. Pp. 54.

Pumps. Oliver United Filters, Inc., 33 West 42nd St., New York, N. Y. Folder illustrating acid-handling Olivite pump. Pp. 4.

Pipe Machines. Beaver Pipe Tools, Inc., Warren, Ohio, illustrating models of pipe-threading machines. Pp. 8.

Centrifugal Castings. The Duraloy Co., Pittsburgh, Pa. Folder describing briefly the technique in making chrome or chrome-nickel centrifugal castings. Pp. 3.

Chains. Columbus-McKinnon Chain Corp., Tonawanda, N. Y. Catalog No. 7, describing alloy-steel chains and containing reference data on chains, hooks, and shackles.

Steam Engines. Troy Engine & Machine Co., Troy, Pa. Catalog containing tables, and engine data, engine construction, drawings, and illustrating vertical- and horizontal-type steam engines. Pp. 48.

INDUSTRIAL NOTES

The Electroline Company, of 4121 South LaSalle St., Chicago, Ill., announces that it has purchased the exclusive manufacturing and selling rights in the United States and in all foreign countries except the United Kingdom on wire rope and cable fittings covered by the H. C. Fiege Patents.

A. R. McMullin has been appointed manager of the New York office, at 60 East 42d St., of the Nordberg Manufacturing Company.

American Foundry Equipment Company announces the appointment of M. B. Heisner as sales engineer in Colorado, Wyoming, and New Mexico, with office at 303 Sugar Building, Denver, Colo.

The Intermountain Belting and Packing Company has been appointed the Denver representative of the Macwhyte Company, manufacturer of wire, wire rope, and slings.

Stanley M. Mercier has joined the sales and engineering staff of the Boston Woven Hose & Rubber Company, Boston, Mass.

Cutler-Hammer, Inc., manufacturers of electric motor-control apparatus, announce the opening of their Los Angeles sales office at 1331 Santa Fe Ave., Los Angeles, Calif., with W. G. Tapping in charge.

R. S. Weiner has resigned after a long period of service with the Sullivan Machinery Company. He is located at Pottawattomie Park, Michigan City, Ind.

Federated Metals Corporation, subsidiary of American Smelting & Refining Company, has announced the opening of its newly erected plant and general offices, on June 15th, 1936, at East 26th and Indiana Sts., Los Angeles, Calif.

The National Metal Show will be held Oct. 19 through 24 in the Public Auditorium in Cleveland, Ohio. The show is sponsored by the American Society for Metals. Exhibits at the show will be varied and it is announced that the technical programs will be comprehensive.

Morris Machine Works, of Baldwinsville, N. Y., announces that changes in its executive personnel, incident to the death of Windsor Morris, have resulted in the election of Carl Lager as president and Pierce J. McAuliffe as vice-president and general manager.

Edward A. Livingstone has recently been appointed manager of alloy tube sales for The Babcock & Wilcox Tube Company, Beaver Falls, Pa.

American Hoist & Derrick Company, St. Paul, Minn., announces that Harry J. Kicherer has been appointed works manager. Mr. Kicherer comes from the Caterpillar Tractor Company, Peoria, Ill. He was formerly a Saint Paul man, having previously been with the Russell Grader Company before it was absorbed by Caterpillar. He graduated as a mechanical engineer from the University of Iowa and has had twenty years of practical experience in the manufacturing of construction equipment, road machinery, and other mechanical products.

SUMMARY OF

MONTHLY COMMENT . . . DAILY AND AVERAGE MONTHLY

THE TREND OF BUSINESS in non-ferrous metals, based on operations at fabricating plants, continues upward. Producers of copper, lead, and zinc are certain that actual consumption of metals was higher during September than in the preceding month. Prices ruled firm. Our index number of non-ferrous metal prices for September was 73.01, against 72.70 in August, the advance resulting from higher monthly averages for zinc and tin. Devaluation of the franc caused a little unsettlement in London prices but no uneasiness here.

Copper came within an "inch" of advancing to 10c., Valley. The export quotation, reduced to a refinery basis, was above domestic parity on several occasions, and, except for the continued opposition of the conservatives, the price would undoubtedly have advanced one-quarter cent. Buying improved on the developments abroad, and domestic sales for September totaled 40,769 tons, against 25,503 tons in August and 175,484 tons in July. Demand was chiefly for December-January metal. During August domestic stocks of refined copper were reduced 12,966 tons and foreign stocks were down 13,777 tons, a total of 26,746 tons. Another reduction in stocks is in prospect for September, even though mine output is being increased here and abroad. Settlement of a strike at Katanga's refinery in Belgium, announced late in the month, is expected to relieve the tight spot situation abroad. Scrap copper has been moving slowly, because of the strong views of holders and intake during September in the United States was the lowest in years.

Business booked in lead was above the average for the third consecutive month. Stocks are being reduced and the market is moving into a firmer position. During August the domestic stocks of refined lead were lowered by 12,848 tons. Shipments to consumers during August totaled 46,388 tons.

Zinc was quiet in September, which was expected because of the heavy purchases reported late in the preceding month. The price was established at 4.85c., St. Louis, on the first day of September, an advance of 5 points. Increased cooperation among foreign producers is thought likely.

Refined platinum, after advancing to $70 per ounce on speculative activity, declined to $64, effective Sept. 28. Antimony was advanced to 12½c. per pound, and quicksilver to $88 @ $92 per flask. Tin was firm on improved buying for account of domestic consumers.

United States Market

1936 Sept.	Electrolytic Copper Domestic (a)	Electrolytic Copper Export (b)	Straits Tin New York	Lead New York	Lead St. Louis	Zinc St. Louis
1	9.525	9.400	43.125	4.60	4.45	4.85
2	9.525	9.400	42.875	4.60	4.45	4.85
3	9.525	9.400	42.875	4.60	4.45	4.85
4	9.525	9.425	43.600	4.60	4.45	4.85
5	9.525	9.450	43.750	4.60	4.45	4.85
7	Holiday	9.475	Holiday	Holiday	Holiday	Holiday
8	9.525	9.475	44.625	4.60	4.45	4.85
9	9.525	9.475	45.200	4.60	4.45	4.85
10	9.525	9.450	44.875	4.60	4.45	4.85
11	9.525	9.525	44.500	4.60	4.45	4.85
12	9.525	9.575	44.500	4.60	4.45	4.85
14	9.525	9.600	45.250	4.60	4.45	4.85
15	9.525	9.650	44.875	4.60	4.45	4.85
16	9.525	9.600	44.500	4.60	4.45	4.85
17	9.525	9.575	45.000	4.60	4.45	4.85
18	9.525	9.575	46.000	4.60	4.45	4.85
19	9.525	9.575	46.000	4.60	4.45	4.85
21	9.525	9.575	45.500	4.60	4.45	4.85
22	9.525	9.600	45.000	4.60	4.45	4.85
23	9.525	9.575	45.000	4.60	4.45	4.85
24	9.525	9.575	45.175	4.60	4.45	4.85
25	9.525	9.575	45.300	4.60	4.45	4.85
26	9.525	9.525	44.675	4.60	4.45	4.85
28	9.525	9.525	45.250	4.60	4.45	4.85
29	9.525	9.525	45.400	4.60	4.45	4.85
30	9.525	9.500	46.000	4.60	4.45	4.85
Av. for month	9.525	9.523	44.754	4.60	4.45	4.85
Averages for Week						
Sept.						
2	9.525	9.375	42.950	4.60	4.45	4.817
9	9.525	9.450	44.010	4.60	4.45	4.850
16	9.525	9.567	44.750	4.60	4.45	4.850
23	9.525	9.579	45.417	4.60	4.45	4.850
30	9.525	9.538	45.300	4.60	4.45	4.850
Calendar Week Averages						
Sept.						
5	9.525	9.413	43.246	4.60	4.45	4.842
12	9.525	9.496	44.740	4.60	4.45	4.850
19	9.525	9.596	45.271	4.60	4.45	4.850
26	9.525	9.571	45.108	4.60	4.45	4.850

Silver, Gold, and Sterling Exchange New York and London

1936 Sept.	Sterling Exchange "Checks"	Sterling Exchange "90-day demand"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
1	5.03125	5.02375	44.750	19.6875	138s 2½d	$35.00
2	5.03125	5.02375	44.750	19.6875	138s 3 d	35.00
3	5.03625	5.02750	44.750	19.6250	138s 2½d	35.00
4	5.03750	5.03000	44.750	19.6250	138s ½d	35.00
5	5.03500	5.02875	(e)	19.5625	138s 1½d	35.00
7	Holiday	Holiday	Holiday	19.5625	138s 1½d	Holiday
8	5.04750	5.04000	44.750	19.6250	137s 10½d	35.00
9	5.06000	5.05250	44.750	19.5625	137s 5½d	35.00
10	5.05625	5.04875	44.750	19.5000	137s 7½d	35.00
11	5.05750	5.04875	44.750	19.5000	137s 6½d	35.00
12	5.05750	5.04875	(e)	19.4375	137s 6 d	35.00
14	5.06375	5.05500	44.750	19.4375	137s 5 d	35.00
15	5.06375	5.05625	44.750	19.4375	137s 4 d	35.00
16	5.06000	5.05125	44.750	19.5000	137s 6½d	35.00
17	5.06375	5.05500	44.750	19.4375	137s 4 d	35.00
18	5.06125	5.05250	44.750	19.4375	137s 5½d	35.00
19	5.06375	5.05500	(e)	19.5000	137s 4½d	35.00
21	5.06375	5.05500	44.750	19.4375	137s 4 d	35.00
22	5.06625	5.05750	44.750	19.5000	137s 4½d	35.00
23	5.06625	5.05625	44.750	19.4375	137s 2½d	35.00
24	5.06125	5.05125	44.750	19.4375	137s 3 d	35.00
25	5.02000	5.00500	44.750	19.5000	137s 9½d	35.00
26	4.93500	4.92000	(e)	19.7500	(f)	35.00
28	4.93000	4.92000	44.750	20.0625	140s 9 d	35.00
29	4.95000	4.93375	44.750	19.9375	140s 7 d	35.00
30	4.94500	4.93250	44.750	19.8750	140s 2 d	35.00
Av. for month	5.03455	.....	44.750	19.579	.....	35.00
Averages for Week						
Sept.						
2	5.03000	.....	44.750	.....	.....	.....
9	5.04325	.....	44.750	.....	.....	.....
16	5.05979	.....	44.750	.....	.....	.....
23	5.06417	.....	44.750	.....	.....	.....
30	4.97354	.....	44.750	.....	.....	.....

Calendar week averages: New York Silver, Sept. 5th, 44.750; 12th 44.750; 19th, 44.750; 26th, 44.750.

(e) No quotation (Saturday). (f) No market because of devaluation of the franc.

The above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis, add 0.225c. per pound, the average differential for freight and interest charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.300c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than the *E. & M. J.* average for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order issued April 24, 1935, the U. S. Government's price on newly mined domestic silver was established at 77.57. Handy & Harman's quotation for domestic silver, .999 fine, was 77c. per ounce throughout September.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

THE MARKETS

PRICES OF METALS . . . MISCELLANEOUS QUOTATIONS

London Market

1936	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic	Standard					
Sept.	Spot	3M	Bid	Spot	3M	Spot	3M	Spot	3M
1	38.4375	38.6875	42.7500	188.3750	185.2500	17.0000	17.0625	13.5625	13.8125
2	38.5000	38.7500	42.7500	187.5000	184.5000	17.1250	17.1875	13.4375	13.7500
3	38.4375	38.6875	42.7500	187.0000	184.5000	17.3125	17.3750	13.3750	13.6875
4	38.6250	38.8750	43.0000	188.7500	186.2500	17.4375	17.5000	13.3750	13.6875
7	38.7500	39.0625	43.0000	191.5000	189.1250	18.0000	18.0000	13.5000	13.7500
8	38.8750	39.1250	43.0000	191.7500	189.5000	18.1250	18.1875	13.6250	13.8750
9	38.4375	38.6875	43.0000	194.0000	191.7500	17.9375	17.9375	14.0000	14.3125
10	38.9375	39.1875	43.0000	195.5000	192.2500	18.2500	18.2500	14.2500	14.5000
11	39.0000	39.2500	43.2500	193.0000	190.1250	18.3125	18.3125	14.1250	14.3750
14	39.1875	39.3750	43.5000	198.0000	194.2500	18.3125	18.2500	14.3125	14.5625
15	39.0625	39.3125	43.5000	196.5000	193.7500	18.5000	18.4375	14.3125	14.5625
16	38.9375	39.1250	43.2500	194.2500	191.7500	18.5625	18.5000	14.4375	14.6875
17	38.8125	39.0625	43.2500	194.5000	192.7500	18.4375	18.3750	14.3125	14.5625
18	38.9375	39.1875	43.2500	198.2500	196.1250	18.3750	18.3125	14.0625	14.2500
21	39.1250	39.3750	43.5000	198.0000	195.3750	18.3750	18.3125	14.0625	14.2500
22	38.9375	39.1875	43.5000	195.2500	193.2500	18.1875	18.1250	14.0625	14.2500
23	38.7500	39.0000	43.1250	192.2500	190.7500	18.0000	17.9375	13.8750	14.1250
24	39.0000	39.1875	43.2500	196.0000	193.7500	17.9375	17.8750	13.8125	14.0625
25	39.3750	39.5000	43.5000	198.5000	196.5000	17.8750	17.7500	13.8750	14.1250
28	39.3750	39.5625	44.0000	200.0000	197.8750	18.0000	17.9375	14.0000	14.2500
29	39.5000	39.6250	44.0000	200.5000	197.7500	18.1250	18.0000	13.8750	14.1250
30	39.1250	39.2500	43.7500	203.5000	200.0000	18.0000	17.8125	13.6875	13.9375
Av. for month	38.915	.....	43.267	194.676	.....	18.009	17.974	13.906	14.159

Current Prices—Miscellaneous Metals, Ores, and Non-Metallic Minerals

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(October 1, 1936)

Miscellaneous Metals

Aluminum, ingot, 99 plus per cent, lb.	19@21c
Antimony, domestic, spot, lb.	12.250c
Bismuth, ton lots, lb.	$1.00
Cadmium, lb.	75c@$1.05
Chromium, 97 per cent grade, lb.	85c.
Nickel, electrolytic cathodes, lb.	35c.
Magnesium, 99.8 per cent, carloads, lb.	30c.
Palladium, troy oz.	$24.00
Platinum, (official quotation) troy oz.	$64.00
Quicksilver, flask of 76 lb., 100 flasks or more	$88.00@$92.00
Radium, mg. radium content	$40.00
Selenium, 99.5 per cent, lb.	$2.00
Silicon, minimum 97 per cent, spot, lb.	16.50c.
Tellurium, lb.	$1.75@$2.00
Thallium, 100 lb. or more, lb.	$6.50
Titanium, 96 to 98 per cent, lb.	$6.00
Zirconium, commercially pure, lb.	$7.00

Metallic Ores

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 45@47 per cent, c.i.f., long ton	$16.50@$16.75
Iron Ore, Lake Superior, long ton:	
Old Range bessemer	$4.80
Mesabi bessemer	$4.65
Old Range non-bessemer	$4.65
Mesabi, non-bessemer	$4.50
Lead (Galena) 80 per cent Joplin, Mo., ton	$49.00
Manganese Ore, c.i.f. Atlantic ports, long ton unit:	
52@55 per cent	26c.
49@51 per cent	26c.
44@47 per cent	25c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2	42c.
Tungsten Ore, per unit of WO_3:	
Chinese duty paid	$15.25
Domestic Scheelite	$15.75
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton.	$31.50

Metallic Compounds

Arsenious Oxide (arsenic) lb.	3½c.
Cobalt Oxide, 70@71 per cent, lb.	$1.41@$1.51
Copper Sulphate, 100 lb.	$4.00
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb.	$1.29
Sodium Sulphate, bulk, ton	$13.00@$15.00

Alloys

Beryllium-Copper, Master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$30.00
Ferrochrome, 65@70 per cent chromium, 4@6 per cent carbon, lb.	10c.
Ferromanganese, 78@82 per cent, gross ton	$75.00
Ferromolybdenum, 50@60 per cent Mo, lb. of Mo contained	95c
Ferrosilicon, 50 per cent, gross ton	$69.50
Ferrotungsten, 75@80 per cent, lb. of W contained	$1.30@$1.40

Non-Metallic Minerals

Asbestos, f.o.b. mines ton:	
Canadian (Quebec)	
Crude No. 1	$550@
Crude No. 2	$200@$225
Spinning fibers	$90@$150
Paper stock	$32.50@$37.50
Shorts	$11@$14.50
Vermont	
Shingle stock	$47.50
Paper stock	$35@
Cement stock	$23@
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 95 per cent $BaSO_4$, less than 1 per cent iron	$5.50
Bauxite, long ton:	
Domestic, chemical, 55@58 per cent	$6@ $7.50
Domestic, abrasive, 78@84 per cent	$12.50@$15.00
Dalmatian, 50@55 per cent	(a)$5.50@ $7.00
French, 56@59 per cent	(a)$6.50@ 7.50
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, bulk	$7.00@ $9.00
Delaware, No. 1	$14.00@
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85-5 per cent, all rail movement, ton	$18.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00@
Dead-burned, f.o.b. Washington	$22.00@
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in.	15@30c.
2 x 2 in.	30@50c.
3 x 3 in.	75@$1.00
3 x 4 in.	$1.00@$1.25
4 x 6 in.	$2.00@$2.50
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.50
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a)12@12½c.
Silica, water-floated, in bags, 325 mesh, ton	$16.00@$40.00
Sulphur, Texas mines, long ton	$18.00@
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$8.50@ $9.00
Tripoli, Missouri, ton:	
40 mesh, cream colored	$15.00@
200 mesh, cream colored	$25.00@

(a) Nominal.

Iron and Steel

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$20.00
Basic	$19.00
No. 2 Foundry	$19.50
Steel, base prices, Pittsburgh:	
Billets, gross ton	$30.00
Structural shapes, 100 lb.	$1.90
Bars, 100 lb.	$1.95

MONTHLY AND YEARLY AVERAGE PRICES

Silver and Sterling Exchange

	New York		London Spot		Sterling Exchange	
	1935	1936	1935	1936	1935	1936
January	54.418	47.250	24.584	20.250	489.207	496.115
February	54.602	44.750	24.818	19.796	487.278	499.908
March	59.048	44.750	27.380	19.663	477.635	496.952
April	67.788	44.892	30.986	20.245	483.596	494.139
May	74.356	44.869	33.865	20.248	488.587	496.850
June	71.940	44.750	32.346	19.770	493.245	501.817
July	68.216	44.750	30.500	19.590	495.558	502.178
August	66.366	44.750	29.476	19.490	496.815	502.519
September	65.375	44.750	29.255	19.579	492.917	503.455
October	65.375	.....	29.368	.....	490.577	.....
November	65.375	.....	29.284	.....	492.277	.....
December	58.420	.....	25.563	.....	492.715	.....
Year	64.273	.....	28.952	.....	490.034	.....

New York quotations for silver not eligible for sale to U. S. Government, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		(a) Electrolytic	
	1935	1936	1935	1936	1935	1936	1935	1936
January	8.775	9.025	6.583	8.358	28.077	34.706	31.261	38.788
February	8.775	9.025	6.341	8.566	27.175	35.313	30.244	39.463
March	8.775	9.025	6.526	8.708	28.518	36.040	31.607	40.227
April	8.775	9.169	7.328	8.849	31.231	36.975	34.763	41.131
May	8.775	9.275	7.794	8.819	33.344	36.690	36.733	40.839
June	8.634	9.275	7.307	8.790	30.799	36.324	34.039	40.357
July	7.775	9.352	7.350	8.993	31.024	37.217	34.261	41.228
August	7.979	9.525	7.738	9.297	32.646	38.259	35.976	42.375
September	8.504	9.525	8.146	9.523	34.036	38.915	37.952	43.267
October	8.967	.....	8.514	.....	35.226	.....	39.609	.....
November	9.025	.....	8.414	.....	35.229	.....	39.396	.....
December	9.025	.....	8.414	.....	35.097	.....	39.313	.....
Year	8.649	.....	7.538	.....	31.867	.....	35.430	.....

New York quotations, cents per pound. London, pounds sterling per long ton (a) Bid quotation.

Lead

	New York		St. Louis		London			
	1935	1936	1935	1936	1935 Spot	1935 3 Mos.	1936 Spot	1936 3 Mos
January	3.692	4.500	3.542	4.350	10.321	10.514	15.397	15.494
February	3.528	4.515	3.378	4.365	10.216	10.413	16.022	16.141
March	3.579	4.600	3.429	4.450	11.012	11.188	16.608	16.767
April	3.692	4.600	3.542	4.450	12.231	12.459	16.097	16.234
May	3.962	4.600	3.812	4.450	13.861	13.940	15.530	15.601
June	4.020	4.600	3.870	4.450	13.776	13.806	15.170	15.259
July	4.123	4.600	3.973	4.450	14.451	14.511	15.856	15.954
August	4.254	4.600	4.104	4.450	15.774	15.792	16.772	16.859
September	4.413	4.600	4.263	4.450	16.262	16.315	18.009	17.974
October	4.512	.....	4.362	.....	18.209	18.209	.....	.....
November	4.500	.....	4.350	.....	17.938	17.935	.....	.....
December	4.500	.....	4.350	.....	16.803	16.828	.....	.....
Year	4.065	.....	3.915	.....	14.238	14.326	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

Tin

	Straits, New York		Standard, Spot, London	
	1935	1936	1935	1936
January	50.916	47.234	231.193	209.731
February	50.063	47.962	227.381	207.081
March	46.962	48.037	215.726	213.080
April	50.154	46.963	223.513	209.313
May	51.138	46.352	227.602	202.429
June	51.108	42.204	227.586	183.167
July	52.297	43.021	232.397	185.957
August	50.463	42.579	222.935	183.731
September	49.126	44.754	223.929	194.676
October	51.160	.....	226.891	.....
November	51.864	.....	226.452	.....
December	49.794	.....	220.075	.....
Year	50.420	.....	225.473	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1935	1936	1935 Spot	1935 3 Mos.	1936 Spot	1936 3 Mos
January	3.730	4.848	11.994	12.207	14.488	14.719
February	3.714	4.859	11.819	12.000	15.125	15.391
March	3.894	4.900	12.095	12.250	15.983	16.190
April	4.030	4.900	12.891	13.128	15.181	15.334
May	4.220	4.900	14.534	14.685	14.536	14.777
June	4.299	4.880	13.734	13.898	13.896	14.122
July	4.325	4.783	14.065	14.185	13.579	13.826
August	4.535	4.800	14.714	14.938	13.528	13.759
September	4.669	4.850	15.414	15.616	13.906	14.159
October	4.825	.....	16.440	16.674	.....	.....
November	4.850	.....	16.193	16.372	.....	.....
December	4.850	.....	15.091	15.278	.....	.....
Year	4.328	.....	14.082	14.269	.....	.....

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Cadmium and Aluminum

	Cadmium		Aluminum	
	1935	1936	1935	1936
January	55.000	105.000	20.000	20.000
February	55.000	105.000	20.000	20.000
March	58.462	105.000	20.000	20.000
April	65.000	105.000	20.000	20.000
May	65.000	105.000	20.000	20.000
June	65.000	105.000	20.000	20.000
July	65.000	93.462	20.000	20.000
August	70.000	90.000	20.000	20.000
September	75.625	90.000	20.000	20.000
October	85.000	.....	20.000	.....
November	85.000	.....	20.000	.....
December	101.800	.....	20.000	.....
Year	70.491	.....	20.000	.....

Aluminum in cents per pound, 99 per cent grade. Cadmium, cents per pound.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1935	1936	1935	1936	1935	1936
January	14.111	12.736	72.760	76.769	34.000	36.885
February	14.250	12.967	72.500	77.000	34.000	35.000
March	14.250	13.072	72.500	77.000	32.846	34.115
April	14.029	12.673	72.500	76.731	32.000	32.846
May	12.712	12.410	72.135	74.940	32.000	32.000
June	12.500	11.707	71.460	74.192	32.000	36.346
July	12.500	11.245	70.538	73.423	32.000	39.308
August	12.500	11.125	69.000	73.923	31.333	49.577
September	13.177	11.740	69.208	85.280	36.000	68.960
October	15.322	.....	71.750	.....	37.615	.....
November	14.217	.....	74.348	.....	38.000	.....
December	13.820	.....	75.200	.....	38.000	.....
Year	13.616	.....	71.992	.....	34.150	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

Pig Iron

	Bessemer		Basic		No. 2 Foundry	
	1935	1936	1935	1936	1935	1936
January	19.00	20.00	18.00	19.00	18.50	19.50
February	19.00	20.00	18.00	19.00	18.50	19.50
March	19.00	20.00	18.00	19.00	18.50	19.50
April	19.00	20.00	18.00	19.00	18.50	19.50
May	19.00	20.00	18.00	19.00	18.50	19.50
June	19.00	20.00	18.00	19.00	18.50	19.50
July	19.00	20.00	18.00	19.00	18.50	19.50
August	19.00	20.00	18.00	19.00	18.50	19.50
September	19.00	20.00	18.00	19.00	18.50	19.50
October	19.00	.....	18.00	.....	18.50	.....
November	20.00	.....	19.00	.....	19.50	.....
December	20.00	.....	19.00	.....	19.50	.....
Year	19.167	.....	18.167	.....	18.667	.....

Iron in dollars per long ton. F.o.b. Mahoning and Shenango Valley furnaces.